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THE MAGAZINE OF SCIENTIFIC PROGRESS

OCTOBER 1960

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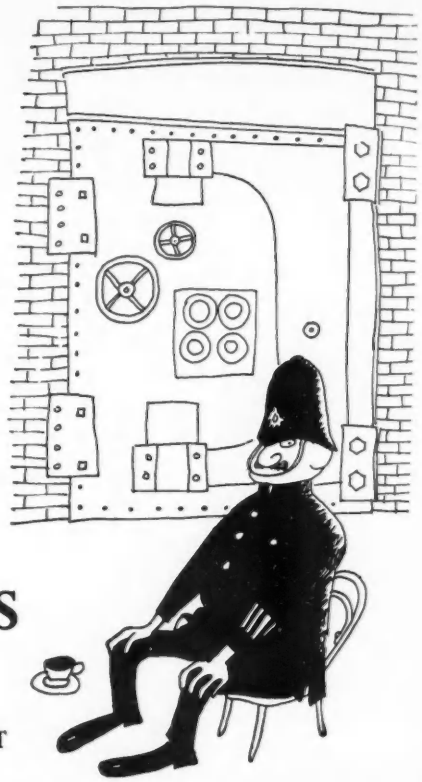

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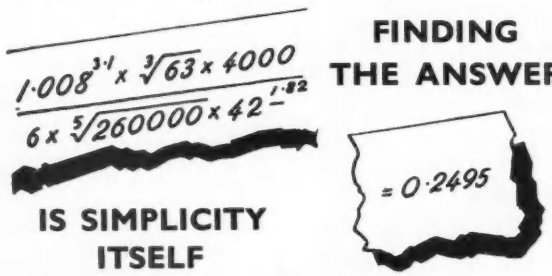

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An authoritative report by Canadian diplomat Dana Wilgress

DISCOVERIES ABOUT VIRUSES
Current research in virology has led to discoveries about the shape, constitution, and manner of reproduction of certain viruses

BIOLOGICAL TESTS IN THE SOVIET "ARKNIK"
New details of animal experiments carried out in a Russian spaceship

SWEARING
A study of annoyance and social swearing in a small isolated group

SCIENCE AT BOARD LEVEL
The second in a series on science in industry by Ritchie Calder

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S. Edward Gamarekian

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11 Gate Street, Kingsway, W.C.2
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Subscriptions, Distribution, and Business Communications to
Jarrold & Sons Ltd,
St James, Norwich. NOR 50 P

Advertisement Agent
J. Arthur Cook,
9 Lloyd Square, W.C.1
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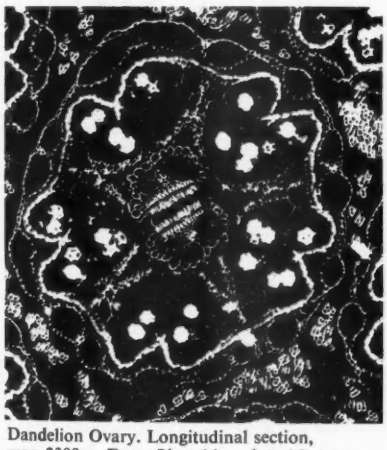

Dandelion Ovary. Longitudinal section, mag. 2300×. From *Plant Marvels in Miniature* (See p. 454)

DISCOVERY

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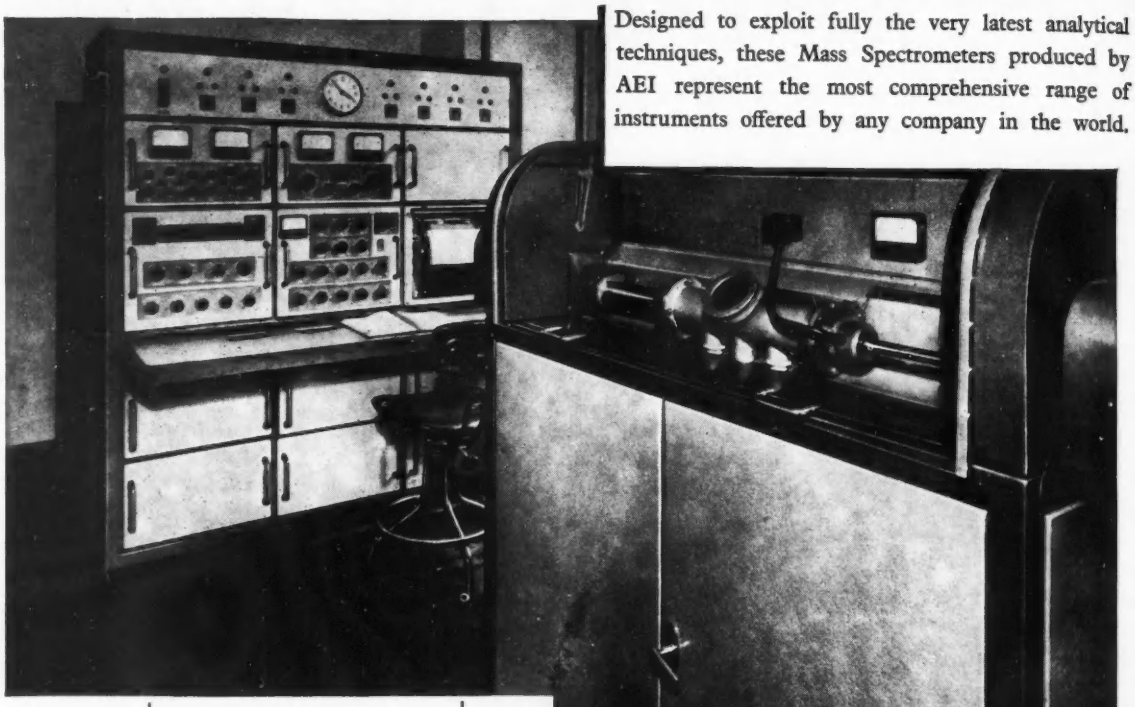

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THE HUMAN FACTOR IN INDUSTRY
THE SCIENTIFIC APPROACH

The World is at last waking up to the importance of human problems in industry. For this there are many reasons. The central one is, of course, severely practical. Man is himself a major element in industry's costs and, in a fully employed economy, one which is in short supply. But there are further considerations. The theologian, for instance, would argue that work is a necessary condition of man's existence. Whether or not we wholly accept this proposition, it will be generally agreed that man's requirements from his work go far beyond the receipt of an adequate financial reward. It is idle to view industry in complete separation from leisure and the whole of community life. What happens in one has sharp repercussions on the other and, paradoxically, steps which may make for the smoother running of industry may at the same time indirectly impoverish our lives.

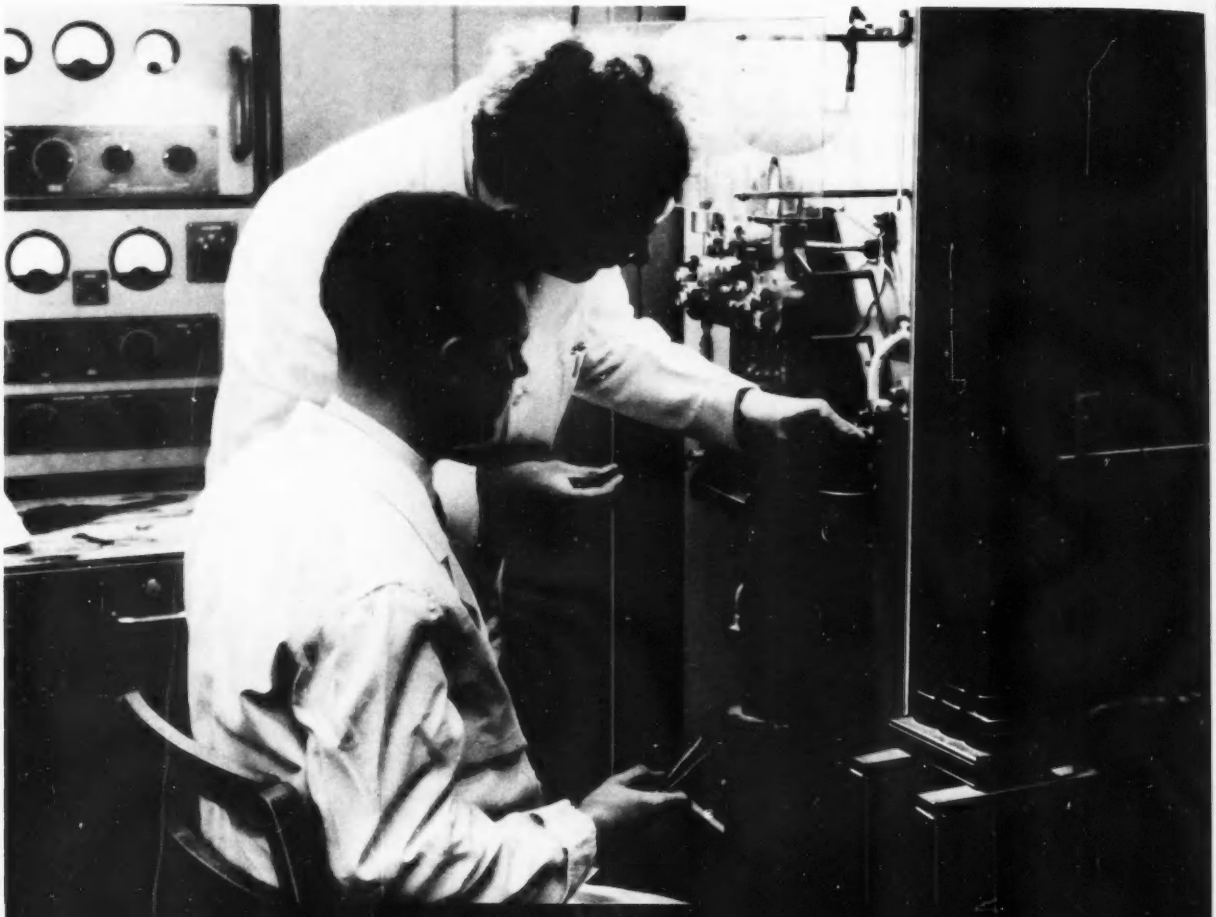
"The proper study of mankind is man" is no new battle cry but the poet's words assume a special importance today. For while, to paraphrase Prof. Toynbee, the present is the first age in which people have dared to think that civilisation's benefits would at last be available to the whole of mankind, the human problems left unsolved are indeed vast and frightening. Thus it is not enough to consider the situation simply in terms of securing the most efficient release of human energy in industry, important though this is. It is also necessary to relate this to a fuller understanding of how industrial society actually works. For a long time, the resistance against research in this field was considerable. The case was difficult to argue in specific terms, a wide range of disciplines being involved, and the benefit to a particular undertaking seemed elusive. Management tended to fear a threat to its authority, while trade unionists suspected that the main purpose was simply to get more out of the workers. Universities and government were not too anxious to be closely involved. Happily, the scene is changing; yet as far as scale, scope and finance are concerned, the effort is still on all too narrow a front. Credit must, of course, be paid where it is due. There was the specialised work initiated before the war by the National Institute of Industrial Psychology and the Medical Research Council, the studies in personnel selection and operational research effected largely by the Service Departments during the war, recent and current studies by the Tavistock Institute of Human Relations and the British Institute of Management, the projects carried out at the universities (notably at Liverpool, Durham, and Edinburgh), the generosity of the foundations, and the stimulus of the British Productivity Council. There was the work initiated by appropriate DSIR committees, thanks largely to American counterpart funds, and carried on more widely through international gatherings such as last year's Zürich conference on "fitting the job to the worker". This record is not unimpressive. Nevertheless, there is a problem in ensuring that what *is* done is adequate and that there is a centre for providing co-ordination and a focus for activity.

Related is the problem of bringing researches in this field together into one cohesive discipline. Herein lies the significance of the comparatively new science of ergonomics —human engineering. Ergonomics may be summarised as the study of man in relation to the environment in which he works and involves *inter alia* the application of anatomy, physiology, and psychology. Allied to it is cybernetics, the study of man in relation to a particular job or machine. These disciplines do not include a full investigation of man's social environment but they do involve a welcome attempt to study the *rapport* of man and industry systematically and by means of the scientific method. The advent of ergonomics and cybernetics has focused attention on a wide range of important topics—the need to relate an understanding of human biology to engineering, the significance of muscular work, the length of and need for rest, problems of age, sex, height of work and posture, controls, and the memory factor, sensory information and speed of reaction, lighting, noise, and the general working environment. This list could be endless. From this it may be apparent that the substance of industrial relations has until recently proceeded along very conventional lines. Technical change has taken place primarily on the basis of technical considerations and very little study has preceded it. Now people are beginning to realise that even if workers generally do operate the equipment they are given as best they can, the whole question of machine-design merits more profound thought.

The need, then, is for the fullest study, not merely in the laboratory but on the shop floor, not only in large firms but in small and medium-sized undertakings. While the disciplines of work-study have an important part to play, the times call for the broadest possible field-research, embracing not only ergonomics and cybernetics proper but the wider considerations of a social and community character, such as welfare, profit-sharing and the social character of automation. Is enough work being undertaken?

One further consideration should be stressed. If scientific studies of this nature are to have enduring value, they must win the confidence of industry and its "inhabitants". They can only be effective if the scientific practitioner is himself recognised as part of the industrial unit and not an intellectual "outsider". Indeed, only where research into human relations forms a recognised part of industry's operations can it make its fullest contribution. A sense of unity and confidence between those being studied and those who are studying is vital.

R.K.M.



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THE PROGRESS OF SCIENCE

REPORT FROM ANNUAL MEETING OF BAAS

Approximately 4100 people were registered at the British Association's meeting in Cardiff last month. Most of the papers, as usual, summed up recent developments and revealed little that was new. The week-long session, consequently, attracted more teachers, students, and members of the interested segment of the general public, than scientists. About half of those who registered came from the Cardiff area and meetings and events that were open to the public drew an additional 3000, bringing the total attendance to about 7000. Many had difficulty deciding how to divide their time among the technical sessions, tours, and other activities offered simultaneously by the fifteen sections—Mathematics and Physics, Chemistry, Geology, Zoology, Geography, Economics, Engineering, Anthropology, Physiology and Biochemistry, Psychology, Botany, Education, Agriculture, Sociology, and Corresponding Societies. The following are summaries of some of the papers presented:

THE EFFECT OF GRAVITY ON THE GROWTH AND FLOWERING OF TREES

Relatively little is known about the effect of gravity on large plants and trees because of the technical difficulties of carrying out experiments on this scale. For many years, certain horticulturists on the Continent have claimed that the flowering of fruit trees could be increased and shoot growth checked by pulling down or "arching" the branches but these claims had never been substantiated by detailed and controlled experimentation.

Dr K. A. Longman of the University College of Wales (Aberystwyth) reported that experiments with larch, apple, and birch trees now show conclusively that gravity has a major effect on growth and flowering. For example, male flower buds of larch that began to develop on the lower sides of the horizontal twigs stopped growing when the twigs were turned over at an early stage; buds then began to flower underneath again. Also, when the upward-growing branches of young larch trees were brought to a horizontal position or pointed downwards, many more flowers formed. (The natural sagging of larch branches may be one of the factors that brings the tree into its flowering phase.) Young apple trees that were grown horizontally in pots bore more flowers at an earlier age than trees grown upright. In addition, their shoot growth was reduced and they formed spur shoots instead of longer branches. Reduced growth was also found in seedlings of other trees when they were grown horizontally. Surprisingly, however, birch trees which were grown upside-down (through holes in the bottoms of boxes) grew *more* than the trees do normally in an upright position. Except for this one anomaly, the investigations showed that the leading shoot of a tree must be grown at an angle well above the horizontal if it is to grow strongly and exert "apical dominance" over the branches.

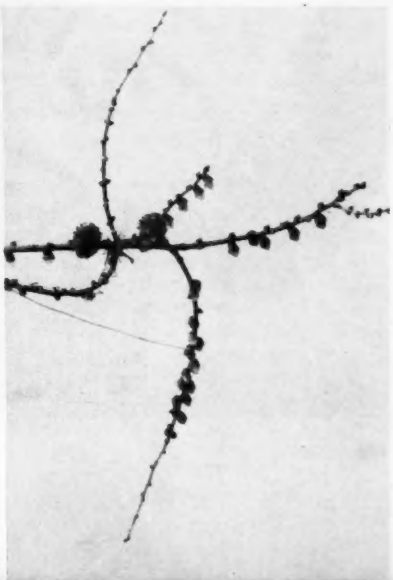
A MATHEMATICAL MODEL OF THE ECONOMY

A group of research workers at the Oxford University Institute of Statistics have constructed an econometric model of the British economy. Using nearly forty equations involving some seventy variables, they have attempted to obtain genuine structural relationships which would remain valid over a wide variety of circumstances. One of the equations, for example, measures the relative contribution of price changes, the level of unemployment, and trade union pressure to the post-war rise in wage rates. Another shows the relative contribution of hours of work and productivity to the spread between wage rates and wage earnings. Others deal with consumption, prices, profits, exports, imports, the rate of interest, unemployment, etc. A "political" variable has been included to bring in the effect of the party in power. This research is being carried out with two objectives in mind. The first is to obtain a better understanding of how the economic system has been functioning in the past—to determine the degree of interdependency of the many factors at work, so that one has some idea, for example, of how much an increase in wages affects prices. The equations show that a 10% rise in earnings leads to a 4% rise in prices. They also show a 2% increase in prices when the prices of imports go up 10%.

The second objective is to make reliable forecasts, of which there are really two kinds. One is the conditional forecast—what would happen to consumption, for instance, if the purchase tax were cut. The other is the pure forecast—crystal-gazing. The latter has already been tried

(*Left*) Normal and horizontal growth of birch seedlings after four years. On the horizontal trees, leading shoots have made very poor growth while lateral shoots near the base have grown upwards vigorously (arrow).

(*Below*) Larch twigs fixed to point upwards produce no male flowers. Those pointed horizontally grow flowers on the lower side. Those pointed downward have flowers on all sides.



Normal chromosomes of wheat *Triticum aestivum*.

for the first two quarters of 1959 and checked against the actual result. The Oxford team by no means hit the bull's-eye, but they reported they came somewhere in the target area, their forecast being somewhat on the pessimistic side. The production predicted for the first quarter was very close to the actual figure but it was eight points too low for the second quarter. Unemployment was accurately forecast for the first quarter, but the decline during the second was underestimated. Consumption, on the other hand, was overestimated slightly for monetary variables, wage earnings, second quarter. Decreases were forecast for monetary variables, wage earnings, rates, and prices, but they actually increased during this period.

Is the Oxford model a satisfactory tool for analysing the economy? The researchers consider it a useful first step that at least produces some reasonable estimates of important relationships. As a forecasting tool, it may be criticised for its inflexibility and for its presumption in attempting to describe the intricacy of the real world in a set of equations, they admit, but it offers the great advantages of an explicit, consistent, and empirically tested set of economic relationships.

THE MANIPULATION OF WHEAT CHROMOSOMES

Attempts are being made at the Plant Breeding Institute (Cambridge) to improve wheat by introducing foreign chromosomes into its genetic complement.

Many desirable genetic variations that occur in species related to wheat are not found within the plant itself. Rye, for example, has resistance to diseases, tolerance of poor and acid soils, and winter hardiness to a degree that is never found in wheat; species of *Aegilops* and *Agropyron* have disease resistances that are outstanding. Although these species are related closely enough to wheat for hybrids to be made, there is, unfortunately, no pairing between the chromosomes of the different species involved in the hybrids. Consequently, the genes of these species cannot be combined with wheat genes by conventional breeding methods and other approaches must be devised. Wheat (*Triticum aestivum*) has twenty-one pairs of chromosomes; rye (*Secale cereale*) has seven pairs. There is no meiotic association between the chromosomes of the two species in the hybrid which is consequently sterile due to the irregular distribution of the unpaired chromosomes into the gametes. By treating the hybrid with the drug *colchicine*, however, the chromosome number can be doubled. In the doubled hybrid each chromosome has an identical partner with which it pairs at meiosis so that there is regular separation and the formation of genetically balanced gametes. This hybrid is fertile but unsatisfactory because the gene-sets of the two species do not work together entirely harmoniously. By a sequence of backcrosses of the doubled hybrid and its derivatives to wheat, useful modifications can be produced but they have yet to be proved agriculturally satisfactory. This can be carried a stage further in another sequence of hybridisations that should produce superior lines, but experience with them is still too limited to permit comment, according to Dr Ralph Riley of the Institute.

Translocation of segment of rye chromosome II on to wheat chromosome after x-ray exposure (arrow). II carries gene for yellow rust resistance.

A further approach to the problem has been made with x-rays. Irradiation will often cause the breakage of chromosomes; when two breaks occur together, the broken ends may unite in a new way. Attempts are being made to translocate part of a rye chromosome which gives immunity to yellow rust (a fungal disease of wheat) on to a wheat chromosome. One line which holds some promise has already been isolated.

It has been discovered more recently, however, that the removal of a particular wheat chromosome, number V, greatly increases pairing at meiosis. This chromosome carries a gene system which normally limits pairing to identical partners. When hybrids deficient for V were made, there was indeed pairing between wheat chromosomes and those of other species, including rye. Such a pairing must result in the recombination

of the genes of the two species involved. This offers the possibility of incorporating new genetic variability into wheat and, perhaps, of tapping reserves of useful genetic material which have hitherto been inaccessible.

UNDERWATER FARMING

If one fourth of the pests in the sea could be eliminated, there could be a tenfold increase in the quantity of fish available, according to Sir Alistair Hardy, Professor of Zoology and Comparative Anatomy at Oxford. This estimate is based on Danish marine biologist Gunnar Thorson's conclusion that only 1 to 2% of the fish food in the sea is actually eaten by the fish, the major portion being consumed by starfish and other invertebrate predators who take in four times as much when compared on a pound for pound basis. If only 2% of the available food supply is now being eaten by fish, the elimination of a quarter of the pests would increase the food available to the fish by a factor of about ten.

How can the pests be eliminated? Prof. Hardy predicts man will one day systematically drag combing devices over the sea floor to weed out the undesirable creatures. A hundred years from now, he says, underwater tractors manned by frogmen may be dragging starfish eradicators over the bottom. Whatever the future holds, any such farming of the sea will require much more pure ecological research to determine which of the animals should be eliminated.

The quantity of fish might also be increased by fertilising the water with phosphates and other chemicals, but this can only be feasible in certain land-locked arms of the sea; the oceans are too vast to be treated in such a way. It would also be profitable to transplant young fish from overcrowded coastal banks to nutrient-rich regions but this technique is not likely to be used by any one nation when all the others are free to reap the benefit. Prof. Hardy predicts the time will come when the need for more food brings about the close international co-operation required to make such a scheme work.

SYMPOSIUM ON WORLD FOOD AND POPULATION

All fifteen sections of the British Association joined together for an unprecedented all-day symposium on the increasingly serious food problem resulting from population growth, particularly in the underdeveloped parts of the world.

Six leading authorities presented various aspects of the problem: birth control, disease, land use, economic conditions, industrial and technological needs, the use of machinery, fertilisers, and the political and sociological obstacles in some of the hungry countries.

The Food Supply

In his opening statement, the Deputy Director-General of FAO, Dr Norman C. Wright, showed that present trends in food production are inadequate. The gap can only be bridged by stepping up the food production in the deficient areas and this is a technically feasible thing to do, Dr Wright stated. No less than 60% of the people in the world live in countries in which the average *per capita* consumption is less than 2200 calories—600 less than the level in Britain during the currency crisis of 1946–7 when, according to an extensive survey, children and adults began to lose weight. To be sure, the food requirements in many of the underdeveloped countries of the tropics and sub-tropics are lower than in Britain because of the higher temperatures, the smaller stature, and the lower level of working activity, but these people may be caught in a vicious circle in which poverty leads to lower activity which, in turn, leads to greater poverty. Undernutrition, in addition, causes a drop in mental alertness, a lack of coherent and creative thinking, apathy, depression, and irritability, all of which—in extreme instances—lead to a loosening of moral standards and social ties. Undernutrition also makes its victims more vulnerable to disease.

In most of the underdeveloped countries, the type of food available often causes malnutrition, even when the calorie level is adequate. Staple cereals and starchy roots constitute 66% of the diet in Africa and 71% of that in the Far East as compared to 25% in the North American diet. The total protein, on the other hand, is only 57 grams per person per day in the Far East compared to 92 in North America. Even more striking are the differences in animal protein consumption—7 grams per day in the Far East compared to 66 in North America. The lack of variety in the diets of the less-developed countries, particularly the shortage of animal products, results in shortages of vitamins and minerals which, in turn, lead to deficiency diseases that are seldom encountered in the more developed countries. The most widespread and damaging is kwashiorkor, a disease that most frequently afflicts young children after they have been transferred from a milk diet to one that consists largely of cereals. The typical symptoms in the acute condition are oedema, wasting, and skin sores, accompanied by liver degeneration; unless promptly treated with supplementary protein, a child in this condition usually dies. Although the acute cases are a small percentage, less acute cases aggravate the effects of other diseases, resulting in a high mortality rate. Other deficiency diseases are avitaminosis A, pellagra, rickets, and nutritional anaemia.

Protein malnutrition in a three-year-old Guatemalan girl showing oedema and hyperpigmentation of the skin. (*United Nations*)

Recent estimates of food consumption indicate the average has probably risen slightly above the low pre-war levels in the less-developed countries, but any such improvement is almost negligible in relation to the need. To bring the world diet up to a reasonable level by 1980 (if the world population increases from just under 3000 million to over 4000 million as expected) it will be necessary to increase the world production of milk, meat, eggs, and fish by not less than 100%. If the number reaches 6000 million by the year 2000, as forecast by the United Nations, there will have to be a 200% increase in animal products. This need will not be met if the present slow trends of food production are not drastically stepped up. A distribution of surpluses cannot begin to solve the problem; the surplus grain produced each year is only about 1% of the total world figure.

continued on page 456

SPECULATIVE RESEARCH

RITCHIE CALDER

The discovery of polythene was the unforeseen result of a study of high-pressure reactions, and offered dynamic evidence that there is much to be said for basic research with no specific end-product in mind. This is the first of a series on the role of science in industry.

There is a terrain in science, well trodden but difficult to define. It lies in the border country between the universities and industry but remote, one might say, from the shopping centres. It may be an enclave in the universities, with research endowed by, or under contract to, industrial concerns; it may be neutral territory, like the research stations of the Department of Scientific and Industrial Research, or, indeed, the Harwell Atomic Energy Research Establishment; or it may be inside an industrial concern.

It is not "pure research", in the sense of academic disinterestedness; nor is it "applied research" in the sense of a specified programme seeking a specified answer. When the Board chairman wants to sound magnanimous, he may call it "basic research"; if he wants to reconcile his shareholders, he may call it "fundamental applied research"; if he has no use for it, he may dismiss it as "wild-cat research"; and if he is frank, he may, with justification, call it "speculative research".

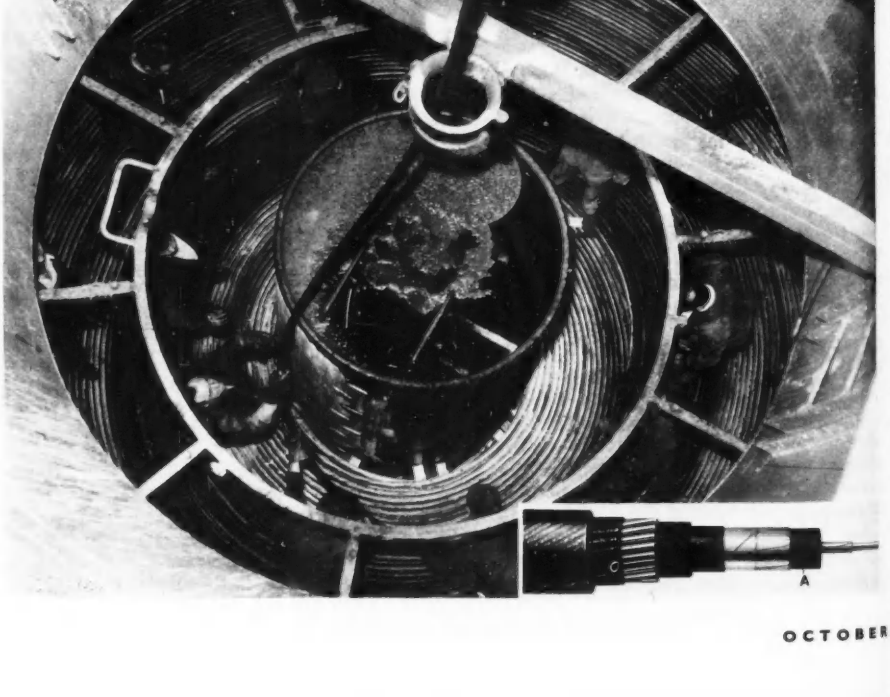
The French call it "Oriented Fundamental Research"—research directed to a specific field of inquiry but not to a foreseeable commercial result.

"Speculative research" was a description current thirty years ago in the Alkali Division of Imperial Chemical Industries when, in the worst years of the Depression, they dared to ask the Board to risk money on a series of research projects with no predictable outcome nor anticipated profit. The Board concurred.

The pay-off of that "speculative research" was polythene, the plastic which played a definite and acknowledged part in winning the Second World War and of which 855,000 tons was produced last year.

Thanks to the careful book-keeping on that project, we know exactly what that piece of "speculative research" cost. Between 1930, when the consent of the Board was obtained, and 1936, when polythene entered the pilot-plant stage, the amount spent was £19,193, including equipment, salaries, and the postage stamps. Apart from ICI's own

Ritchie Calder, one of Britain's leading science writers, has reported on scientific developments in every medium—newspapers, magazines, books, films, radio, and TV. His latest book—expected out soon—is "The Inheritors", a study of man and his environment throughout the ages.



Polythene found immediate application in the first trans-Atlantic cable, shown being coiled into the cable-laying ship. Sectional view of cable is at inset lower right. *A* indicates the polythene insulating layer. It was also found ideal for radar. *(Submarine Cables Ltd)*

polythene production of 90,000 tons a year, the royalties accruing to ICI from licensing of production elsewhere runs into millions of pounds.

A POLICY OF "EXTREMES"

There were historic reasons why the Alkali Division, at Winnington, in Cheshire, took the initiative. Before the merger which brought Imperial Chemical Industries into being in 1926, the Alkali Division had been Brunner, Mond, and Co. Ltd, and Ludwig Mond, co-founder with John Brunner, had had very definite ideas about industrial research. Back in 1889 he had said in his presidential address to the Society of Chemical Industry:

> "The statement is frequently made that 'Necessity is the mother of invention'. If this has been the case in the past, I think it is no longer so in our days. . . . We can now foresee in most cases in what direction progress in technology will move, and, in consequence, the inventor is now frequently in advance of the necessities of his time. He may even create new wants—to my mind a distinct step in the development of human culture. It can no longer be stated that 'Necessity is the mother of invention', but it may be truly said that *steady, methodical, investigation of natural phenomena is the father of industrial progress.*"

That was the dictum invoked, and accepted, in 1930, when, beyond the applied, adaptive research which was already being done at Winnington, the research manager, H. E. Cocksedge, and his colleagues urged a policy of "extremes" on the Board. The "extremes" which they wanted to investigate were: very low temperatures; high temperatures; high vacuums; and high pressures.

Until then, the work at Winnington, although of high scientific calibre, had been concerned with assisting manufacturing processes or promoting specific new products. Now they were asking for a *carte blanche* to investigate, without any preconceptions, the mechanism of chemical reactions under extreme physical conditions.

"Very low temperatures" was a non-starter. Or, rather, it had already started eight years before when T. Verschoyle of Brunner, Mond had, under F. A. Freeth's direction, undertaken basic investigations into low-temperature properties of gases, for the purpose of purifying gases by low-temperature distillation. He had covered a great deal of the field and so attention was concentrated on the other three. Of the three lines pursued, under the scheme of "speculative research", the most disappointing, academically and practically, was "high temperature". One result was the technique for extruding alumina for very high-temperature refractories, but that was transferred to another firm in 1938. Nor was there any real "breakthrough" in "high vacuum". One promising line of inquiry was molecular distillation, to upgrade drying oils (such as linseed) without destroying ingredients which are useful to paint and varnish manufacturers. After several months of experimenting with this on the pilot scale, it was decided that "the commercial field left to ICI was without prospect of remunerative development within a reasonable time".

THE SIGNIFICANCE OF FAILURE

The "casualties" discarded from the programme are significant because they raise the question: "How speculative can 'speculative research' afford to be?" Obviously, with hindsight from 1960, when we are wrestling with problems of thermonuclear fusion temperatures and see the importance of cryophysics and cryochemistry (working in the region of Absolute Zero) and of industrial vacuum techniques, one may ask whether, if the original *schema* had been pursued, the longer term investment in abandoned fields might not also have "paid off".

The survival of "high pressures" had (if one can be mystical about balance-sheets) a sense of destiny. There were plenty of discouragements, quite a few misadventures, and, during the first five years, little enough to show for it—to show, that is, to the purse-holders.

The reprieve was in part due to history. The making of synthetic ammonia (a development at Billingham after the First World War) had involved high-pressure work—although "high" now sounds an exaggeration since the "Billingham range" was only 4000 lb./sq. in. But Dr F. A. Freeth had, in the early twenties, seen the need for sustained research work in pressure chemistry. There was close contact with Prof. Kammerlingh Onnes's laboratory in Holland. In 1931 an ICI grant was given to Dr Michels of Holland to finance the investigation into pressures up to 50,000 lb./sq. in.

Various members of the Alkali Division's research staff were sent to Holland to work with Dr Michels. They included R. O. Gibson and M. W. Perrin, both of whom were to have distinctive parts to play in the story of polythene. Equipment was ordered from Holland and was installed at Winnington in February 1931. The first experiments, attempting to separate mixtures of solids or high-freezing-point liquids. under extreme pressures were quite negative but useful "know-how" was gained in the use and improvement of the equipment. After the failure of this "pressure-freezing" attempt the apparatus was modified to permit liquid/gas reactions, of interest to the Dyestuffs Division.

The two gases considered most likely to react with organic liquid were carbon monoxide and ethylene. They did; they produced a substance, "polyacrolein". The next step was to try benzaldehyde and ethylene. In his notebook, for March 27, 1933, Gibson recorded "waxy solid found in reaction tube".

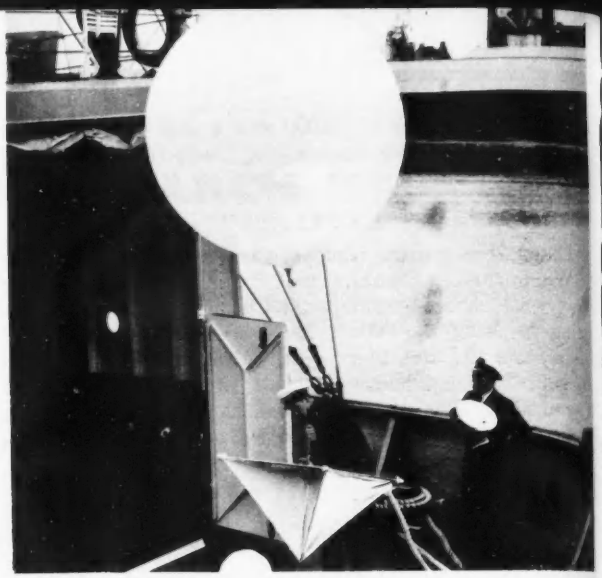
When this was analysed it was found to contain no oxygen, and it was therefore concluded (quite rightly) that the substance contained no benzaldehyde and was, in fact, a new form—a polymer—of ethylene.

This discovery (how significant no one then realised) was reported to the Dyestuff Group Research Committee on April 7 with the note, "the work on the reaction between ethylene and benzaldehyde has been abandoned".

The pessimism arose from a series of explosions and a fire. The risks were too great. Ethylene was declared an unsafe gas and work on it was stopped until stronger equipment and safer arrangements could be made. Indeed, at the end of 1933, the closing down of the entire high-pressure chemistry programme was seriously discussed. It

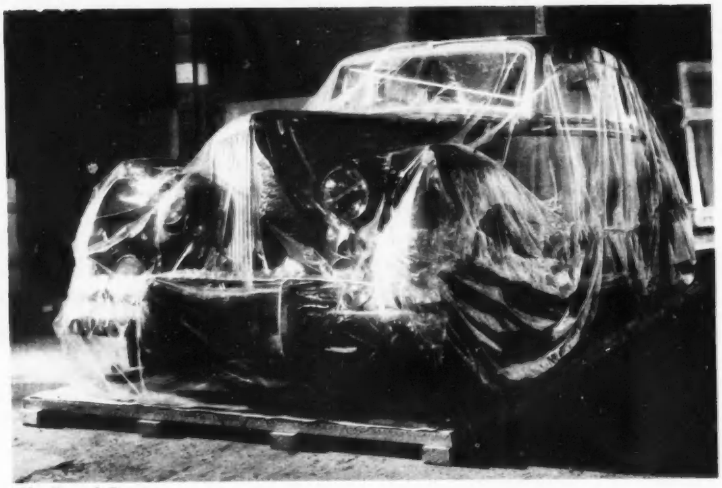
(*Imperial Chemical Industries Ltd*)

Other uses followed quickly . . . kitchen ware . . .



(*Central Press Photos Ltd*)

. . . balloons for weather research . . .



(*The Kynoch Press*)

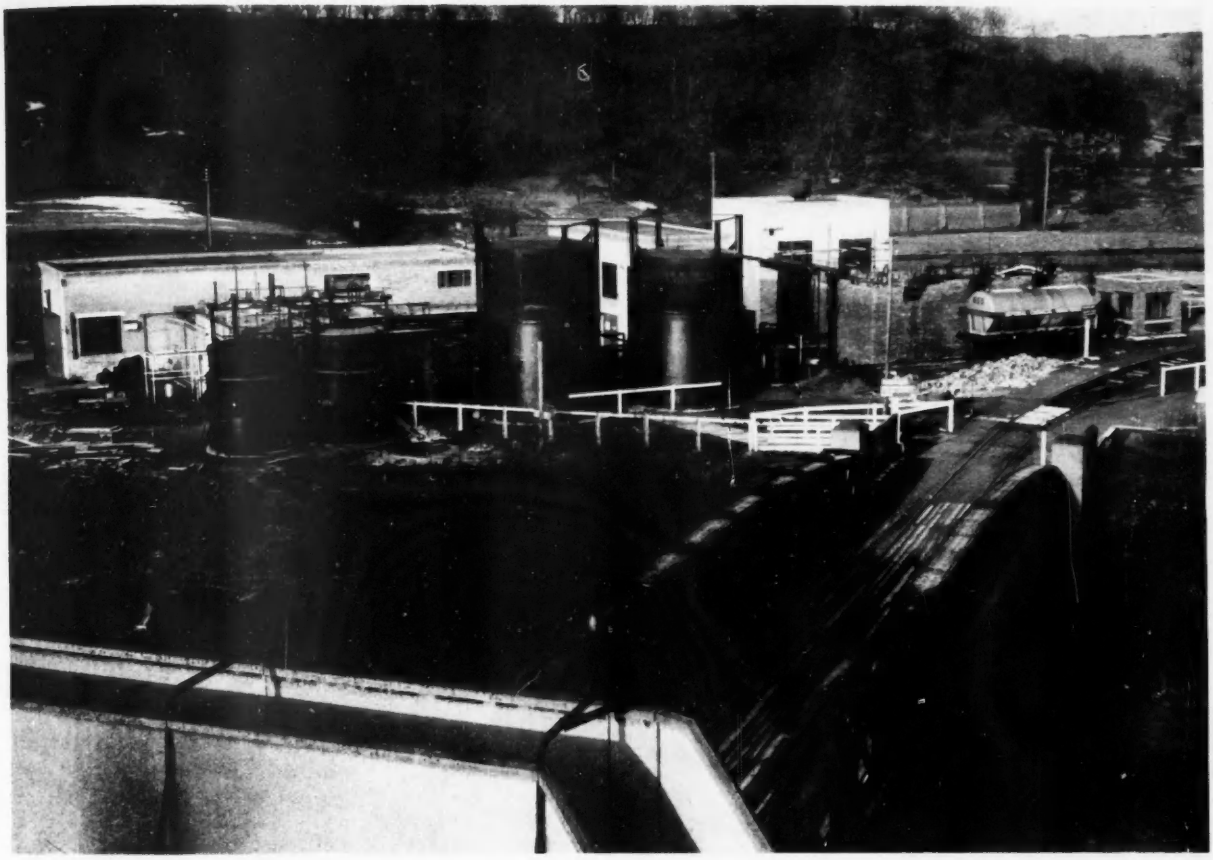
. . . protective wrappings to prevent tarnishing and corrosion . . .

. . . wrappings to keep fruit and vegetables fresh . . .

(*Briggs Photo Studio*)

. . . and a variety of household appliances.

(*Sidney Bishop Studio*)



(Imperial Chemical Industries Ltd)
The first polythene pilot plant went into operation at the Wallerscote Works of ICI on the day the Germans marched into Poland.

was "touch and go", and it is interesting to find that the arguments for continuing did not include the polymerisation of ethylene. Gibson and his colleague, Fawcett, who had, together, made the discovery of the "waxy solid", were transferred to other work. Perrin, who was presently joined by E. G. Williams, was provided with equipment for even higher pressures and proceeded with systematic studies of academic interest.

THE NIGHT-WATCH EXPERIMENTS

In the autumn of 1935, Perrin reopened the question of making polythene. The risks were re-examined, and it was decided that the improved arangements would remove any personal danger.

As a big bang during work-hours would have been embarrassing (particularly as ethylene was still banned), Perrin and W. D. R. Manning, the engineer, stayed on after hours. The ethylene pressure in the apparatus was raised to 30,000 lb./sq. in. No explosion happened but the pressure began to fall and a gas leak was suspected. However, the experiment was carried on until all the available ethylene in the laboratory had been used up. Then the apparatus was cooled off and about three-quarters of an ounce of snowy-white polythene was found. This was presented to the research manager the following day (December 18, 1935) and permission was given to proceed with experiments. (Since the night-watch experiments had been unauthorised, the first *recorded* experiment is dated December 20, when it was carried out by J. G. Paton, E. G. Williams, and F. Bebbington, who obtained eight grams of the substance.)

Polythene had been rediscovered, but it still gave no cause for excitement or promise of its spectacular future. The first hint of possibilities was given in August 1936 when it was shown to a member of the ICI (Dyestuffs) staff, H. A. Habgood, who had recently joined from the cable industry. From his tests, he expressed the opinion that it could be an insulating material superior to guttapercha in the making of submarine cables.

His request for a half-hundredweight sample for larger-scale tests put the "high pressure" team in a serious quandary. So far, the quantities they had obtained could go into a bottle on a shelf. But their experiments (at pressures as great as that of a 15-inch naval gun, at the moment of firing) were still unpredictable; they were never sure whether they were going to get polythene or an explosion, with nothing but carbon and hydrogen as the

(*Imperial Chemical Industries Ltd*)
Large-scale production is now going on at the Wilton Works. Dark structure in background is part of an oil-cracking plant.

chemical residue. Nor did they really know how the polythene reaction took place.

When a pilot plant to produce the new requirements was erected, it was provided with a safety valve which was triggered off if the reaction showed signs of getting out of control. Releasing gases at 30,000 lb./sq. in. through a narrow pipe into the atmosphere produced a report like that of an anti-aircraft gun. There were no serious mishaps.

Research discovered the explanation of the erratic behaviour of the experiments. The reaction depended on the presence of oxygen. The commercially produced ethylene which they used sometimes contained 0·1% of oxygen. This was really too much. With 0·08%, they got polythene; with 0·1% they got an explosion. The difference between success or failure was 0·02%.

THE FIRST TON

By Christmas 1938, a ton of polythene had been made in the pilot plant and most of it had been sold for large-scale evaluation. Telegraph Construction and Maintenance Ltd had made an experimental length of submarine cable and the Post Office engineers had seen that its electrical properties made it ideal for television cables.

"Hard" orders were coming in and the Alkali Division and Imperial Chemical Industries had to back "speculative research" with capital investment. First, the pilot plant was moved from the laboratory site to Wallerscote, and the first production plant, modelled upon it, was built around it. It came into operation on the day Germany invaded Poland, but even before that, the directors had decided to double its size.

This was a fortunate decision both for the company and for the country because, in the next few months, experiments had shown that polythene was "just the job" for radar, and when Britain "became an island again", after the retreat from Dunkirk, practically all its production had been earmarked for radar.

As Sir Robert Watson Watt has said: "The availability of polythene transformed the design, production, installation, and maintenance problems of airborne radar from the almost insoluble to the comfortably manageable."

It is certainly no exaggeration to say that that "waxy solid found in the reaction tube" in 1933, and almost forgotten, had become a decisive factor in the winning of the war. It prevented the war's being lost in the fateful days of the Battle of the Atlantic when airborne radar enabled

a hundred U-boats to be sunk in a very few weeks. And, as an indispensable feature of radar equipment of Britain and her American ally, on land, on sea, and in the air, it made possible the successes of the bomber squadrons, the naval forces, and the liberating armies.

Today, the uses of polythene are innumerable—cosmic-ray balloons and peanut bags; cables and colanders; drain-pipes and draining-boards; sheets for "moth-balling" battle-ships or for curing concrete; irrigation pipes ploughed into the desert or filaments woven into shirt-collars: frost-proof plumbing and babies' pots; nothing too big or too small. In its versatility and range of uses, it is outstanding even among the remarkable family of plastics to which it belongs. To begin with it was thought of as a substitute for gutta-percha as a cable insulator or as a superior kind of paraffin wax. It is not really a substitute for anything; it has properties entirely of its own—properties which will be more fully exploited when the practice of atomic irradiation becomes a convention and not a novelty.

Polythene has been chosen as an example of "oriented fundamental research" because it derived from examination of basic principles, with no end-product in mind. One might have taken, by way of contrast, a research which was also basic: Carothers's researches into long-chain molecules, which produced nylon. But that was a study of the nature of polymers whereas in the case of polythene, the polymer was the unforeseen result of a study of high-pressure reactions. The fact that polythene, with different qualities, can also be produced by low-pressure methods (for example, the Zeigler process) shows the rethinking which a basic discovery provokes.

GOING INTO BUSINESS

The story of polythene reveals the "points of decision" which are reached in a big industrial concern. The first was when a Board, at a time of economic stringency, invested in basic research. Before they knew they had "got a winner" they had spent just over £19,000 on the high-pressure investigations. That, in the light of the achievement, does not seem very much, even when it is multiplied three or four times in terms with the comparable costs today, but it was one of these recurring expenditures which directors, auditors, or meticulous shareholders are liable to regard as unredeemed loss, rather as lesser people feel about the unused half of a return ticket—"When do we get our money back?"

The trouble with speculative research is that the time-scale is so indefinite. Not all research directors have the aplomb of Faraday, when Mr Gladstone asked him what useful purpose his electromagnetic induction would have, and got the reply, "Sir, you may be able to tax it." When it comes to presenting a justification to the board for an annual budget, hopeful, but unconfirmed research seems like wishful thinking. And what is the cash value of wishful thinking? As has been seen three of the four basic research projects undertaken (almost like scientific relief work) in 1931 had been abandoned and, before 1936, when polythene was rediscovered, the high-pressure work had found it increasingly hard to justify its existence. The main Board of ICI may not have looked too hard at it when it came forward as part of the annual research budget but the directors of the Alkali Division reviewed it each year with some dubiety.

When did polythene become a practical proposition? When did a scientific fact become self-evident to the business men who had to find the money to make it possible? The answer in the words of one of the research team is, "When we got the first substantial order! We knew we could 'wash our faces'—justify the cost of production equipment—if we could get an order for fifty tons." But they could justify the cost of a pilot-plant stage—move from research to development—on a smaller request. This was the inquiry for a ½-cwt. sample, for tests of polythene as an insulating material, for submarine cables. The pilot-plant results were enough to excite potential customers, and early in 1938, Mr J. N. Dean of Submarine Cables Limited learned about the new plastic, from reading Lord McGowan's speech at the ICI Annual General Meeting. This led to a request for 100 tons for two North Sea cables. Polythene was no longer "speculative". It had "gone into business".

The first production plant was constructed at Wallerscote, in Cheshire, built round the original pilot plant, but it was immediately doubled to meet wartime demands.

As one of the polythene research team put it: "It is one thing to make a discovery; it is another thing to recognise the discovery you have made; and it is something quite different to make other people recognise that the discovery is of commercial importance."

If that "waxy substance" had been noticed before 1926, before the nature of macromolecules was understood, it would not have been recognised at all. In 1933 it was recognised as a polymer but the risks exceeded the interest. In 1935 it was recognised as a substance of chemical interest. In 1936, it was recognised as a substance of electrical interest. In 1938 it was recognised as a discovery of commercial importance. That was "fast going", when one considers the rate of innovation in pre-war years. According to S. C. Gilfillan, in *Technological Trends*, the U.S. Government report (1937) in which he studied the most important inventions of the generation before 1930, the median lapse between the "conception date" (recognition to the point of patenting) and "commercial success" was thirty-three years.

After the war, polythene became part of that far bigger decision of the ICI Board—the £40,000,000 Wilton project. Before the war, polythene had depended on alcohol sources of ethylene. Now the expansion demanded bigger supplies and the ICI's own petrochemical plant on Tees-side could provide ethylene from oil. The polythene plant was established there in 1951.

Presently, structural changes took place within the ICI itself and polythene was removed from the Alkali Division and embodied, with the other polymers, in the Plastics Division. Meanwhile, polythene had spread all over the world, directly as ICI's own product but also through licensing and the leasing of technical "know-how". There is no predictable limit to the demand, nor to the variety of its applications. "Speculative research", which began as an inquisitive investigation of high-pressures, has struck a chemical reef, richer than any Klondyke.

THE EFFECTS OF TELEVISION UPON FAMILY LIFE

WILLIAM A. BELSON

This statement is based upon the BBC report, "Television and the Family"[1] which has just been released. The study was designed and directed by the author and carried out by the Audience Research Department of BBC.

The rapid growth of television since the war, first in the United States and later in Great Britain, naturally led to much speculation about what television was doing to people.

The full facts of this growth have been set out in several publications.[2] Broadly speaking, however, three of its features are highly relevant here. In the first place, the proportion of homes with television sets rose from a fraction of a per cent in 1947 to 40% by the end of 1955. Whilst at that time there were still many differences between those with and those without sets, ownership had penetrated deep into each of the social classes. Moreover, there was every promise of continued growth, for not only was the rate of ownership accelerating, but as early as 1955 television transmitters covered an area in which practically the whole of the population of the United Kingdom lived. In addition to this, the hours of television transmission had steadily increased so that by 1957 the average adult viewer was spending, in winter, about twelve hours a week in viewing evening programmes. Now, in 1960, over 75% of families have sets, most of them receiving commercial as well as BBC programmes. In the circumstances, it is in no way surprising that there should have been—and still is—concern and speculation about the impact of television on the mental and the physical life of the viewer.

The speculation was directed at many different things, but prominent amongst these was *family life*. There were many who argued that television would keep the family together in the home, that it would provide common topics of conversation where perhaps few existed before, that television would produce co-operation between family members in getting household jobs finished in time for television programmes, and generally that it would make the home a more pleasant place to be. There were many, however, including some in prominent positions, who had a far less rosy view of its likely impact. They argued that there would be disputes over programmes, that demoralising influences would be brought right into the viewer's home, and that television would destroy the essentially private and co-operative character of family life.

Conjectures of either kind, some of them bordering on the irresponsible, received widespread publicity and credence, for there were no hard facts against which to test them. The matter is, however, clearly open to research and it was in the belief that a basis of fact was indispensable to any consideration of the problem that the BBC inquiry was undertaken.

THE AIMS OF THE INQUIRY

The inquiry had several quite specific aims. It was intended to measure television's effect on:

(i) the degree to which various members of the family stayed at home together;

(ii) the total amount of activity of a home-centred kind occurring amongst viewers;

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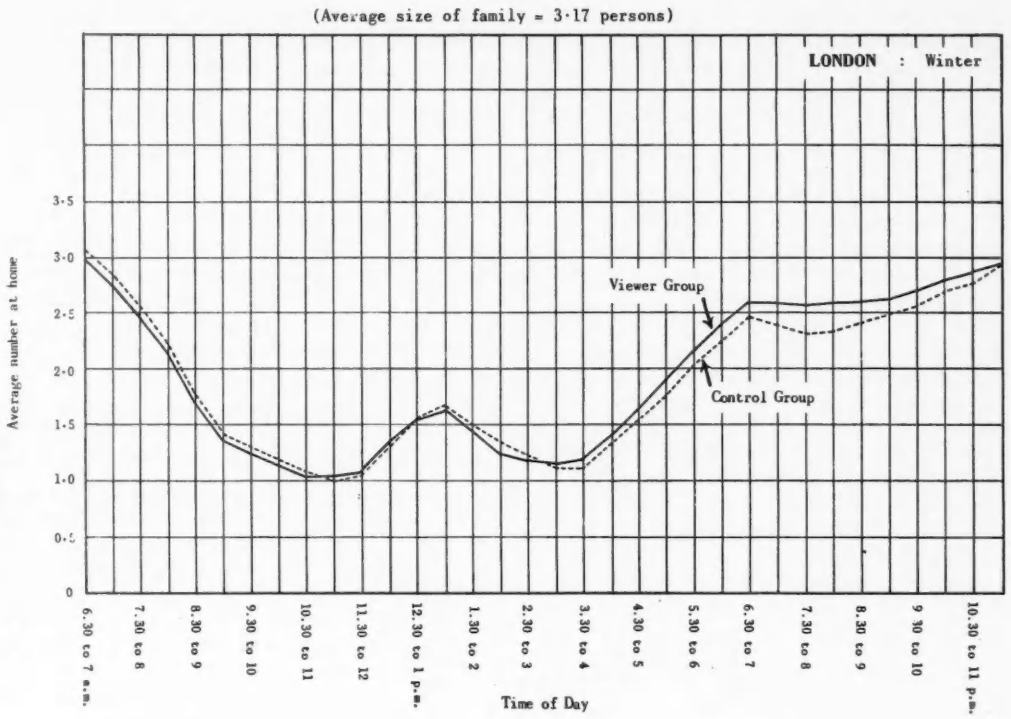

FIG. 1. Television's effect in keeping the family together at home, showing the proportion of the family at home between 6.30 a.m. and 11.30 p.m. on all days of the week.

(iii) the degree to which the various members of the household did things in co-operation.

In addition, the inquiry was intended to provide evidence of television's effect on

(iv) the degree to which viewers received visitors in their homes or went visiting themselves;

(v) the way in which guests in viewer homes were entertained.

METHODS OF INQUIRY

A description of the methods used in the inquiry follows the statement of findings. They are described in further detail in the BBC document and in the articles referred to in the notes at the end.[3]

FINDINGS IN BRIEF

The report makes it quite clear that family life has not remained unchanged—indeed, it is hard to see how it could be otherwise with anything as pervasive as television. It is equally clear, however, that the results of the inquiry do not give support to the many spectacular and sweeping generalisations which have been made about the impact of television on family life.

Some of the changes detected have been of an appreciable kind. For example, there has been: (*a*) a major increase in the number of visitors in viewer homes; (*b*) a sharp redistribution in Wakefield, one of the survey towns, of the times at which the family is at home together; (*c*) change in the "at-homeness" of various groups of young people and also of married couples at the week-end; (*d*) a reduction of the "at-homeness" of the larger family in some sections of the community; and (*e*) change in the degree to which certain forms of entertainment are offered to visitors.

On the other hand, many of the changes set out in the report are small, and this includes two important categories of behaviour, namely "home-centred activity" and "joint-activity" of family members. Again, the "at-homeness" of the family is subject often enough to redistribution rather than to change in the total amount of it. Some of the effects are of a temporary nature. Moreover, there is a considerable tendency for television's impact on various aspects of family life to vary from area to area and to depend on the season of the year.

There follow some details of the findings.

TELEVISION'S EFFECT ON THE AMOUNT OF TIME WHICH FAMILY MEMBERS SPEND AT HOME TOGETHER

The assessment of television's power to keep the family at home together was made in terms of the primary family unit—that is, the parents and such dependent or unmarried offspring as live with them. The survey respondent had indicated, for each member of his or her family, whether that person was at home or not, half hour by half hour, between 6.30 a.m. and 11 p.m. on a specified day. Different respondents did this for different days. An "at home" score for the family as a whole was computed for each half hour. This was simply the proportion of the family at home in that half-hour period. An average for the whole day was also computed. A comparison of the "at-homeness" scores

of the closely matched samples of viewers and non-viewers could then be made, and the residual differences between them, in respect of family "at-homeness", could be interpreted as approximating to the effect of television.

During the hours of evening transmission, television has increased the degree to which the family is together at home. The increase is of the order of 14% for Wakefield (summer), 10% for Birmingham (winter) and 6% for London, both summer and winter. There is a 5–6% increase for London and Wakefield in the afternoon transmission period as well, but relatively little change for Birmingham. During the morning periods and up to 3 p.m. in the afternoon, when there were no television programmes on, there was no evidence of increased "at-homeness". In fact the evidence points strongly to a slightly reduced "at-homeness" in that period, suggesting that viewers compensate for evening "at-homeness" by going out more when television is not on. In fact it is interesting to find that for the total day the aggregate increase in "at-homeness" is of the order of only 3%. We should not of course let this obscure the fact that a *shift* or *redistribution* of the family's "at-homeness" has taken place.

The shift applying to London in the winter, illustrated in Fig. 1, gives a detailed indication of the nature of that particular change.

I must make it clear, however, that this chart is for all days of the week combined and that, depending on the area and the season, the pattern of change for week-days may differ from the pattern for Saturdays and may differ again from that for Sundays.

Families can be grouped by age and size. Whilst for most of them television has increased their "at-homeness", it has not done so for the large family. In fact, for three out of the four surveys, it has tended in the opposite direction. Follow-up studies[4] suggest that the main reason for this is that in the larger families various members go out in the evening because there is little they can do or get interested in when the family sitting-room is crowded with people viewing.

The Married Couple. Television's influence on the married couple is very much on the same pattern: they stay at home together more in the evening, but tend to make up for this to some extent by going out more during the rest of the day. Here, too, it is the couple from the large family which now spends slightly less time at home together. Interestingly, television's effect in keeping the couple at home is greater when both go out to work than when only one is working. The reason for this appears to lie in the fact that when both partners are working they go out more so that there is, as it were, greater scope for change. Television's effect also varies with the occupational background of the couple, but the nature and the direction of that change depend to a marked degree upon region and season.

Young People. The study dealt specially with five groups of young people aged from three to twenty-two years. Television has affected the times at which these people are at home. The changes, however, are more *redistributions* of time spent at home than alterations in the *total amount* of it. Quite frequently television leads to reduced "at-homeness" during the morning and the early afternoon and to an increase in the evening period. There are, however, very few clear-cut differences between the five age groups and, even within single age groups, the nature of the changes brought about by television is by no means constant, varying by area and season. If, however, we speak of the *total amount* of time spent at home, it is clear that on balance television tends to result in children and young people spending just a little more time at home.

The Duration of the Changes. I made analyses of television's effects on family "at-homeness" according to length of set ownership; there is nothing in this analysis to suggest that the effects so far described are of a purely short-term or temporary nature.

THE TOTAL AMOUNT OF ACTIVITY OF A HOME-CENTRED KIND WHICH OCCURRED IN VIEWER HOMES

This particular assessment was based upon a list of twenty activities which had been developed as a representative cross-section of normal home-centred behaviour. The list included such things as: preparation of a shopping list, sorting out papers, feeding the pets, entertaining a visitor. The score attributed to a respondent was the number out of twenty which he had done in the "last seven days".

With the exception of Birmingham, where there had been a moderate reduction, television's effect on home-centred activity was either small or negligible. Whilst there were sharp differences in television's effects on the home-centred activity of different sections of the population, what happens to any of these sub-groups seems to depend markedly upon the region in which they are living, or the season, or both. The one exception is that all four surveys show that the home-centred activity of adult members of families where there are children is reduced as a result of television more than is that of people in families without children. Later interrogation of viewers on this point makes it fairly clear that this is the result of the parent doing somewhat less for the child than before, partly because television does it for him (for example, reading a story to a child, playing with him) and partly because television is the new baby".[4] One other feature of television's effect is that it has narrowed earlier differences in home-centred activities existing between people in different occupational groups.

TELEVISION'S EFFECT ON JOINT ACTIVITY IN THE HOME

This part of the inquiry was also based upon a representative cross-section of activities. This time they were those household activities in respect of which members of the family co-operated and the score was based upon the degree to which family members *co-operated* in them. The twenty items in the list included things like washing the dishes, tidying up, playing gramophone records, checking the shopping and putting it away.

In London and Birmingham surveys, television led to a small reduction in the family's joint activity (about 4%). In Wakefield it led to an increase (8%). In the early stages

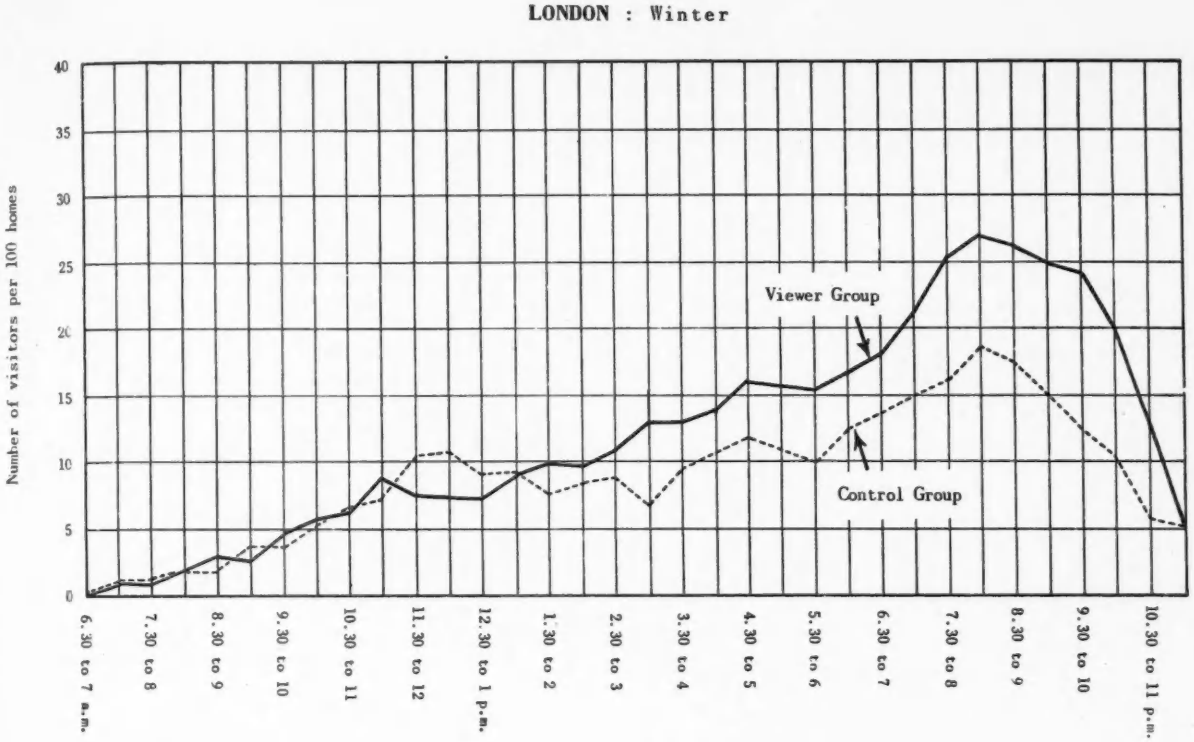

FIG. 2. Television's effect on number of visitors by each half-hour of the day.

of ownership, there may be either increase or decrease depending on the area, but there is a long-term tendency for the amount of joint activity to return to the pre-television level.

Television's effects on different sections of the public can be quite marked, but there is very little tendency for any of these changes to be common to the four surveys. Clearly regional and seasonal factors have a lot to do with who will be affected and how.

TELEVISION'S EFFECTS ON VISITING

In all four surveys there was evidence of a large increase in the number of visitors in viewer homes: for the average half hour, the increase in London was 37% in the winter, and 13% in the summer; in Birmingham (winter), the increase was 33%; in Wakefield (summer), it was 42%. The amount of change varied by time of day, the main increase being in the afternoon and evening periods. At its maximum, which was during evening transmission time, the increase was very large and in several of the surveys almost doubled the pre-television figure. Fig. 2 gives details of the changes in London in the winter.

Some visitors come as expected guests and others just "drop in" casually. With formal or expected visiting, there was an increase in all four surveys. With casual visiting, however, the increase was limited mainly to London in the winter, some of the other surveys providing evidence even of slight reduction. Follow-up interviewing suggests that this was largely because casual visiting interrupted viewing and was not encouraged. There appeared to be much less of a resistance to having your *invited guests* sit down with you to view. There was a lot of variation in these effects according to length of set ownership, but it is only with casual visiting that there is anything to suggest an eventual return towards the pre-television level.

At the same time, television reduces the extent of "expected" visiting done by viewers themselves, and the most likely implication of this is that when most people have sets—and that is tending to be the case now—the level of "expected" visiting in viewer homes will also return towards the pre-television level.

TELEVISION'S EFFECT ON THE ENTERTAINMENT OF GUESTS IN VIEWER HOMES

Television has produced a large number of changes in the way viewers entertain guests in their homes, though here too what happens varies with area and season. Thus there are increases in the proportion offering meals to guests in three of the surveys, but in the fourth it is the offering of light refreshment which has increased. Conversation, a major means of entertaining guests, appears to be reduced by television in the summer but not in the winter. In all but Birmingham there is a sharp reduction in the "showing of things" (but not television) to the guest. That minority activity, "home-entertainment", was increased by television in the winter but decreased in the summer. But some changes are general. As must be expected there is a considerable tendency, in all four surveys, for viewers to replace radio with television as a means of entertaining

the guest. Apart from this there is an overall reduction in the degree to which the guest does something for the host.

CONCLUSION

Whilst it is apparent from this inquiry that family life has not remained unchanged, it is equally clear that the evidence does not support the many spectacular and sweeping generalisations which have been made about the impact of television. The BBC study has answered a number of pressing questions; yet there are still others that call for attention. How does television affect the relationships between family members, particularly those between children and parents? Who gets neglected when one or the other parent is an addicted viewer? How does it affect the moral training of the children? Since there are television sets in the great majority of homes, these and other questions can no longer be ignored.

THE METHODS USED IN THE INQUIRY

Methods of Isolating Effects. If the effects of television are to be measured, they must first be identified. But this at once raises a serious difficulty. Viewing families are subject to a multitude of influences all of which may produce effects upon them, and there is no easy way of correctly attributing such effects as are produced to any one of these influences. Social changes which occur during the period of television's growth are all too often attributed to television. But they are not necessarily anything of the kind. Intricate analysis is necessary before it can be said that a change is in fact due to television.

Some American studies have been based on little more than a comparison of the behaviour of viewers and non-viewers, the difference between them being interpreted as an effect of television. Obviously, however, that difference is a combination of effect *and* of something else, namely of original differences between the people who *did* and those who did *not* become viewers. In other studies there have been attempts to eliminate such original differences by equating (or matching) the two samples in terms of various characteristics—such as age, sex, and class—thought to be sources of difference between viewers and non-viewers.

This was a step forward, but it must be taken much further before there is any guarantee of its being effective. In the first place, there is no point at all in matching in terms of variables that have nothing at all to do with whatever is being studied. If the two samples differ in terms of such variables, it can be of no practical importance, for to match in terms of them can have no effect on the remaining difference (in family behaviour) between them. But where they differ in terms of things that have a lot to do with whatever is under study (family behaviour), that difference will certainly matter. To neglect it would be to confuse the effects of television, with differences arising out of viewers and non-viewers being different *to start with*. Accordingly, effective matching requires a preliminary search for those characteristics which are associated with whatever is under study. These may properly be called the *correlates* of the variable under study; the method which involves finding them and using them is *the Stable Correlate technique*.[3] It is to be contrasted with the common practice of deciding quite arbitrarily *what* the matching criteria are to be. The whole logic of this procedure does of course demand that fresh correlates be found for each of the issues under study. Equally it demands that the correlates or matching criteria chosen should not themselves be open to the effects of television; otherwise their use for matching purposes would result in the whittling away of the very effects it is desired to isolate. In other words, what are needed are *stable* correlates.

Selecting and using the Matching Criteria. In the present inquiry, the search for matching criteria was made amongst some 200 different variables, all of them put up as feasible and all of them included in the survey questionnaire. They included various details about occupational state, job level, conditions of work, possessions of the more durable kind, family composition and background, educational level, size of home, whether relatives live nearby or not. Selection from amongst the 200 was on strictly empirical grounds, involving a measurement of their statistical association with the variable under study. Since television's effects were being studied in relation to forty different kinds of family behaviour, the selection of matching criteria had to be carried out afresh forty times. In each case a small composite of stable correlates was developed on principles sufficient to maximise the available association between the variable under study and the matching composite.

The actual matching procedure which is used in conjunction with this method involves no discarding of cases, but a simple system of reweighting the scores of the people in various of the sub-groups defined by the matching criteria.

Sampling and Questioning. The inquiry was carried out through survey methods in which representative samples of viewers and non-viewers, 8200 in all, completed diary-type questionnaires. These provided information about their own and their family's behaviour both generally and on one of the days during which the diary was in their hands. In order to deal with regional and seasonal differences in television's effects, there were: two surveys in London, one in the winter and one in the summer; a winter survey in Birmingham; a summer survey in a small Yorkshire town, Wakefield.

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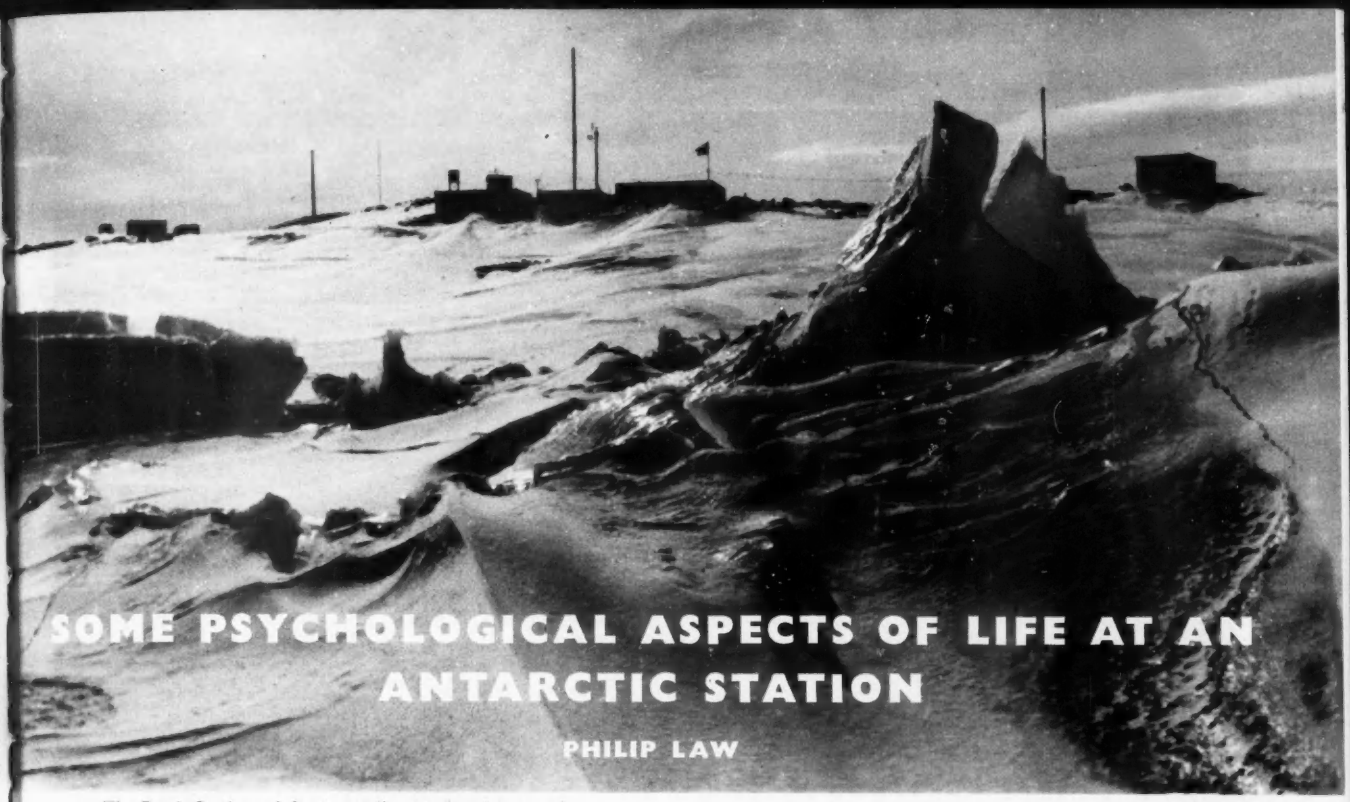

SOME PSYCHOLOGICAL ASPECTS OF LIFE AT AN ANTARCTIC STATION

PHILIP LAW

The Davis Station of the Australian National Antarctic Research Expedition during the winter of 1957.

A sense of isolation, aggravated by the depressing effect of frequent high winds, dull cloudy weather, and the constant battle against the cold, cause psychological strains that are intensified by the upsetting of well-established daily rhythms during the long winter nights and summer days. But there are no problems with money, social status, or gardening.

The word "remote" has its greatest significance at an Antarctic Station. Men who go there in January are cut off from all except radio contact with the civilised world for twelve months. They live for most of the year incarcerated in a little village which man's ingenuity has set up in this isolated spot. And they know that, whatever happens, no help can reach them.

It is the irrevocability of their exile which oppresses them. Their sense of isolation is increased by a number of deprivations—the lack of female companionship, of comforts and luxuries, of variety in food, liquor, and amenities, and of daily contact with a wide range of different human beings.

Among men thus thrown together, trifling personal peculiarities can cause mounting exasperation and harmless peccadillos produce serious resentments. The psychological strains are aggravated by physiological factors resulting from the disturbance of well-established diurnal rhythms of the human body during the long mid-winter night or in the period of continuous summer daylight. Then there is the depressing effect of frequent high winds and dull cloudy weather, and the constant battle against cold.

To balance this rather depressing weight of disadvantages there are a number of alleviations and compensations in antarctic life quite apart from the more obvious rewards such as broadened experience, the gratification of an ambition or a sense of adventure, and the contemplation of magnificent scenery.

First, the existence of an expedition member is socially uncomplicated. There is no money and therefore no financial anxiety. One has no concern about social status, and any petty differences of dress, possessions, and social graces cease to have significance. Nor does one have to balance delicately the rival obligations to one's wife, one's children, one's job, one's garden, and one's sporting acquaintances.

Secondly, a man with ambition and interest in his work can devote himself to it wholeheartedly with little interruption and few distractions.

Thirdly—and this is most important—a man is judged in Antarctica by his companions largely on the basis of his efficiency in his job. A good man thus experiences a double sense of accomplishment—the realisation of having done his job well, and the gratification of knowing that his competence has been appreciated by his fellows.

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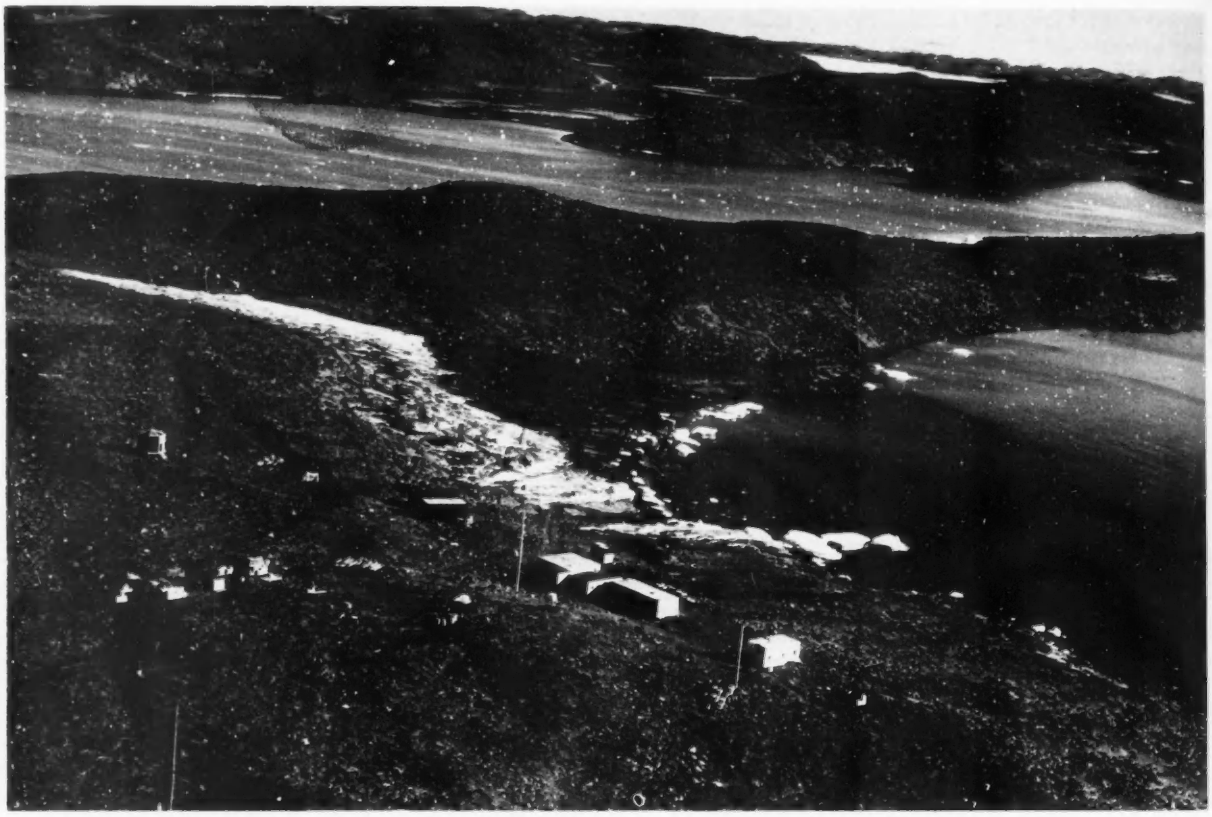

In summer, the ice and snow melt off, and the ANARE Station at Davis stands in the midst of a barren expanse of rock.

STRESSES AND STRAINS

The main stresses at such a station are psychological stresses—those between individuals, those between groups and those between the leader and his party. In a large city a man with peculiar characteristics, strange prejudices, or embarrassing weaknesses, can often escape from these situations merely by avoiding them. At a remote station a man's avenues of escape are considerably restricted, and his chances of hiding his weaknesses are almost nil. Even the desire to hide them disappears.

Although our Australian establishments are run as "classless societies" and everything possible is done to place all members of a team on an equal footing, deeply ingrained social or intellectual differences in men cannot be eradicated overnight and these present some of the worst problems that we experience. They tend to occur mainly amongst technical staff, particularly men of low intelligence and inferior educational qualifications. A man with a strong sense of inferiority may tend to be aggressive and difficult in his relations with other men and therefore become unpopular. This increases his sense of inferiority and the size of the chip on his shoulder, which makes him even more unpopular. There is thus a descending spiral of deterioration in his morale, often accompanied by a developing persecution complex.

Examples of superiority complexes, on the other hand, are not infrequent. Intellectual arrogance is common among young freshly graduated scientists, but the influences at a station tend to correct this fault rather than to accentuate it as the year goes by.

Two kinds of groups or cliques tend to develop at a station. The first kind is simply made up of men performing the same kind of job. Thus, the four radio men, the four meteorologists, the four physicists, and the five RAAF personnel at Mawson are separate self-contained groups each held together by the common aims and efforts of their members. We try to break up these groups when allocating men to sleeping huts, for the members of any one sleeping hut (six or seven men) also tend to form a clique. On one or two occasions cliques formed by a group of older ex-servicemen on one side and the young newly graduated scientists on the other have caused us concern because of the complete lack of sympathy each has displayed for the ideas of the other.

A less healthy type of clique is that formed by malcontents or men who, because of their unpopularity with the rest of the party, are forced to seek each other's companionship. Companions in adversity, men who lack friends gravitate together.

A leader must always suffer to some extent from the loneliness of his position. He must be prepared to accept the fact that most men like to grumble about something

and he will be the obvious target for their dissatisfaction. However, it is far better for dissatisfaction to focus upon an impersonal and vague "Organisation", or its Director, back in Melbourne, than upon the leader at the Station.

All our experience underlines the basic importance of intelligence and education, and much trouble at a station is avoided if men can be chosen who have a reasonable measure of both. Such men seem to have more flexible minds and fewer rigid prejudices. They have wider interests and are not easily bored. Their inner resources are greater and they are more self-sufficient. Above all they have the sense to analyse situations and to use their minds to control their reactions.

Most men at an Antarctic station instinctively realise the need for holding their emotions on a tight rein. For instance, quarrels serious enough to end in a brawl back home rarely terminate in physical violence in Antarctica. Men seem to be innately aware of the irrevocable nature of an actual blow in an environment where for months to come one must daily meet one's antagonist face to face.

Not only is intelligence important as a factor in emotional stresses; it is, in my opinion, a vital factor in dangerous situations where a man's survival is threatened, particularly if the circumstances involve an unfamiliar environment.

It seems as though each man is surrounded by a sphere of known things within which he moves and lives. Beyond this stretches the blackness of the unknown, with its consequent primitive fears and superstitions. For the uneducated, ignorant man of low intelligence the sphere is quite small and the blackness looms terrifyingly close. For the intelligent man, particularly if imaginative and well-educated, the periphery of the sphere of known things has been pushed far back and his roving imagination can push even further out, so that almost no situation in which he can be plunged can be completely unfamiliar.

It is fear which kills, fear which paralyses, fear which either prevents constructive action or produces blind panic. The educated, intelligent man, at whom fear strikes less effectively and who is better equipped mentally to exert the necessary will-power to control it, can therefore often surmount such stress situations where men of lower mental calibre succumb.

Further to this theme, I prefer to choose men who have had a wide experience of bush walking, camping, mountaineering or skiing, not only because this indicates their love of adventure, but because they have experienced Nature in her unfriendly moods and are less likely to be appalled by the fury of the elements.

Mullin and Connery (1959) noted that headaches were the most common psychosomatic complaint and that they occurred more frequently amongst the scientists and officers than amongst the navy enlisted men. They reported that the headaches were apparently related to the sharply felt need for careful control of aggression and they ascribed the difference between the two groups to the more complete repression of their hostilities by the former group.

In our experience, the commonest psychosomatic symptoms have been those associated with the digestive tract, such as dyspepsia and various abdominal pains. Headaches rate far lower in the list and are not more common amongst the intellectuals. Other ills are insomnia, with its consequent ailments, and rheumatic "aches and pains". The most frequently prescribed medicine is aspirin.

When headaches have been notable amongst our intellectuals they have been associated with over-worked, overconscientious men struggling day after day with heavy routines of observation and instrument maintenance in the face of numerous difficulties, rather than with the repression of aggressive tendencies.

Food becomes an item of the greatest importance in Antarctica. All sledging parties, living on hard rations, dream of banquets and most expedition men talk of the exotic foods they will eat when they return. This is not only because the climate and the hard work encourage healthy appetites. In addition, food acts as a psychological compensation for other deprivations.

The graph of the morale at a station shows a fairly regular pattern each year. It starts off at a low level during the relief period, when the men who have just arrived, unsure of themselves in their new environment, feel ill at ease in the presence of the previous, experienced party and long for the departure of the ship so that they can be completely alone with their new possessions and responsibilities. When the ship sails their morale surges up to its highest point, and for several months the general activity and enthusiasm is maintained at this level.

Then the long winter night with its limitation of outdoor activity and its absence of sunshine causes a general deterioration in morale, varying in degree with different parties. The graph rises again when the sun returns and men can busy themselves preparing for spring and summer field trips. Another high point is finally reached in the last two months, when the prospect of relief looms attractively close and the contemplation of unfinished work spurs men who wish to complete their tasks to renewed efforts. (However, any suggestion of a delayed relief can at this stage plunge the party into gloom.) During the return voyage, the men's behaviour is in marked contrast with that exhibited during their outward trip. They are lethargic, lacking in exuberance, cynical, more individually isolated, drained of intense feeling and interested in little except their early delivery to a home port.

The mid-winter low in morale is generally accompanied by insomnia in a large proportion of men. In a big party this is not serious; as most suffer from it, it becomes accepted as normal. Members of the "Insomnia Club" wander about at all hours of the arbitrary "night", play darts or cards, argue interminably, and concoct fantastic brews by mixing malted milk, milk powder, chocolate or coffee, with various proprietary milk-based beverages.

However, in a small party, the situation can be more serious. As we all know, the worst thing to do about insomnia is to worry about it, and a man who is the only "insomniac" amongst four or five sound sleepers is hard to reassure.

The interesting feature of insomnia is that it tends to occur more during the midwinter period of 24-hour darkness than during summer's continuous daylight. No doubt the high peak of outdoor activity which coincides with summer is the differentiating factor here.

The first and foremost requirement is a man's love of his job. Next in line are unselfishness, tolerance, optimism, character, guts, and "stickability".

An accident in which members of a party can lose their lives can have a shattering effect upon morale. The protective illusion of "It can't happen to me" is violently dispelled by death striking in the very midst of the small, closely knit group, and all feel suddenly naked and vulnerable. If the accident occurs in the field the remaining men may tend to avoid further field work. Recovery takes some time, for the removal of specialist men from the station leaves gaps which provide innumerable daily reminders of their loss.

One of the most difficult subjects for study at an Antarctic station is that of sex. What do we know of the sexual disturbances and abnormalities caused by the deprivation of woman's company suffered by men at these stations? We know very little.

We do know that no single deprivation counts as greatly as that of women. However, this matter is much broader than the narrow question of the lack of natural sexual intercourse. I venture to say that, for a number of reasons, sexual deprivation in the narrow sense is not nearly as important as many people might expect; while the lack of female companionship in the wider sense is felt very greatly.

In our experience men seem to accept the absence of any sex life realistically; their attitude can be summed up by the sentence: "There is nothing you can do about it, so the less you think of it the better." Ameliorating factors are, first, the absence of the constant sexual stimulants which abound in a civilised environment (pretty girls, advertisements, sexy magazines and films, and so on), and, secondly, the sublimation of sexual energy into hard work which undoubtedly occurs.

As for homosexuality, I can say we have had no overt cases, although some incipient tendencies in a few instances have been noticed. There seems little doubt that this problem would arise more acutely at an idle than at a busy station. Also, to some extent, overt homosexual trends that are socially acceptable (such as "mateship" or "buddyism" and strong sympathetic and protective behaviour) provide natural male outlets for homosexual instincts and play a part in decreasing the incidence of frank perverted behaviour.

The use of alcohol is a vexed question. Most officers-in-charge, from the pure viewpoint of discipline, would recommend dry stations. However, alcohol in moderation

has certain advantages: it decreases tension and helps men to relax; it removes inhibitions and lets men with grievances "blow off steam". With a good party and a strong leader there is usually no trouble. I have banned strong spirits, but we supply beer and table wines in moderation. There is no ration of alcoholic beverages per man—a non-drinker gets none, and for the others a bulk supply is put out.

Problems have sometimes arisen with occasional newly graduated scientists of considerable ability. Here the problem seems to be one of protracted adolescence and a resentment of any form of disciplined living. A combination of a burning sense of the importance of the "freedom of the individual" with a lack of experience of life and people outside a student environment and a certain amount of intellectual arrogance produces some remarkable behaviour. Priggishness, sarcasm, and a supercilious condescension are in themselves unpopular traits, but when they are combined with undisciplined work, a late rising and a complete neglect of personal hygiene the resultant animosity aroused can be imagined.

There is a general tendency amongst the scientific personnel to wish to turn the clock about by working very late at night and sleeping during the day. This causes resentment amongst men who must rise punctually for schedules.

NEUROSES AND PSYCHOSES IN ANTARCTICA

Fortunately the incidence of severe mental illness at antarctic stations is very low, owing to the care with which men are selected. Neuroses of varying degrees of severity, however, are fairly common and some severe anxiety states have been recorded.

These neurotic states arise from a variety of causes. Frequently they occur amongst men who are brought face to face in this exacting environment with their own ineptitude in some field or other and who suffer from an acute feeling of insufficiency in the face of problems from which there is no escape other than a neurotic one. Aggressive, blustering behaviour is often adopted by such men to hide their feelings of inadequacy.

A typical case is afforded by the "bluffer", the man who "sells himself", when interviewed, at a higher level than his true worth and pretends to competence which he does not possess in order to be chosen. When delivered to a station he finds himself faced with certain exposure amongst critical men with whom his bluff can no longer succeed.

A similar form of anxiety neurosis will sometimes occur in an over-conscientious man who, perhaps quite unjustifiably, begins to worry about successfully coping with his job. Such a man, driving himself to the point of exhaustion, will often develop insomnia and other nervous ailments.

The anxiety state of the authoritarian type of leader who fails to obtain the support of his party is another example of neurotic behaviour. This is a complex matter in which offended ego, a sense of failure, a tendency to drive himself to the limits of his physical strength, and the reaction upon him of the resentment of the antagonised members of his party all play a part.

Homesickness, fear of the dangers of the environment, family problems at home, violent personal antipathies between men—these can all produce neurotic symptoms.

As a result of these anxiety states some striking examples of psychosomatic illness have been exhibited.

Rohrer (1959) has stated that all six people evacuated by U.S. authorities for psychiatric reasons developed symptoms of mental disturbance in from one to four weeks after going ashore in Antarctica. Our experience has been similar, the worst cases of mental disturbance occurring within from two to eight weeks of the departure of the relief ship which landed the men. Apparently the impact of the environment is immediate and severe. Serious breakdowns in Antarctica occur mostly in young men less than 25 years of age, but this is not confined to Antarctic experience.

ADMINISTRATIVE METHODS OF REDUCING THE STRESSES

Nothing is so important for the psychological well-being of a party than the appointment of a first-class leader. And nowhere are the qualities of leadership subjected to more gruelling tests than at an Antarctic station.

However, even given a good party and a good leader, there is much that can be done administratively to reduce the stresses at a station. First, the men must be welded into a team *before* departure. In the city where they first gather, most of the influences are predominantly cohesive. By having the men work together, play together and drink together before their departure, and by lecturing them on all aspects of expedition work, it is possible to build up a solid team spirit, based upon understanding and mutual respect, which has a fair chance of surviving the later stresses to which it will be subjected.

We are realising more and more the value of training and indoctrination of expedition men prior to embarkation. During a special week of lectures, men are given information on the aims and ideals of the expeditions, the scientific and exploration programmes, the use of antarctic clothing and field rations, methods of survival, unloading techniques, administrative and accounting procedures, techniques of travel, first aid, factors governing morale, patterns of behaviour, and desirable and undesirable traits in expedition men. The importance of each job at the station is explained and each man is made to feel that he is an important and, in fact, an indispensable member of the party. On one side, the university graduates are warned against the evils of intellectual arrogance and the misdirected use of their faculties; on the other side, the artisans are given talks aimed at building up their confidence and explaining the points of view of other categories of men in their party. Undesirable patterns of behaviour are instanced and discussed with the combined parties. Finally, talks on leadership and methods which have proved satisfactory in dealing with common stress situations and patterns of undesired behaviour are given to chosen leaders, who are also expected to read official diaries and logs from previous years.

Because a man's avenues of escape at a remote station are very restricted, it is essential that some private and personal refuge be provided to which he can retire to be apart from his companions. At our stations each man has

(*Photos from Antarctic Division, Department of External Affairs, Australia*)

The ANARE Station at Macquarie Island, March 1959.

a separate cubicle containing a bunk, writing desk, chest of drawers, and wardrobe. In addition, each work hut is separate, and men come to regard their work huts as semi-private retreats.

As I have said, an ANARE station is a classless society in which all men have equal rights and partake equally of the general load of camp duties. Even the officer-in-charge takes his turn as mess boy to help wash up, set tables and sweep out. Work loads are arranged to approximate to the upper level of what men can accomplish. Their work is never finished and, as they chase the carrot of allotted tasks which dangles before their eyes, the year races through.

The careful rostering of general duties, the specification of spheres of responsibility, and the printing of an Operations Manual to govern the running of the station—all these show men exactly where they stand and thus prevent unnecessary and damaging arguments and quarrels at the Station.

To prevent anxieties arising (particularly amongst the married men) concerning families and loved ones, some form of radio communication between the men and their next of kin is essential.

At the Stations there is a variety of amenities—library, piano, table tennis, billiards, radiogram, cinema programmes, cards, chess, etc. Of these, the most interesting and probably the most valuable morale-builder is the cinema.

The greatest obstacle to the building of a happy contented well-adjusted party is the difference in cultural levels of various men. What topics of conversation can be common to all? How does a leader prevent the development of an intellectual clique at meals, when the more erudite men gather at one end to discuss philosophical profundities, and the less informed members, tiring of the continual high-brow conversation, sit and jeer and try to break it up? It is here that the cinema is important; not so much because it provides an escape from the environment but because it creates talking points for conversation. After a good show the men can talk for days about pictures they have seen and the relative merits of various actors—and actresses. In such conversations all may participate and no man's opinion is worth any more than another's.

Another great value of the film is that it is a source of *group* enjoyment. Men are brought together and partake together of what the evening has to offer.

Another good topic of general conversation is motor cars, particularly as most men who winter down south return with a year's savings and the firm intention of buying a new car.

A very marked feature of the psychology of Antarctic stations is the hunger for recognition and praise exhibited by many of the men. This is most apparent amongst those with strong inferiority complexes to whom I have already referred. This desire is a perfectly normal one, which is accentuated when the man down south counts up the hardships, the deprivations and the dangers he has to face in carrying out his work. When the task is completed he quite naturally expects a pat on the back. It is possible, also, that in Antarctica he suffers from the lack of such everyday recognition and praise which back at home arises normally in the home environment—the commendation and the loving adulation of mother, wife and children. A good leader can go far towards gaining the loyalty and goodwill of such men by the judicious use of praise, by making sure that other members of the party are notified of the special achievements of individuals, and by guaranteeing that published reports will give adequate recognition of the personal achievements of the separate men.

THE SELECTION OF PERSONNEL—WHY MEN GO SOUTH

Most people with whom I discuss this subject have the impression that the applicants for a job range from very poor on one hand right up through every variation to very good on the other, and that all that is needed by the selector is some measure of omniscience in order to obtain the perfect choice. In practice it is much more difficult. Often, for the highly skilled positions, there are few applications and one is left with very little effective choice at all.

The choice I have learned to avoid most is the group-disruptive egoist. Overweening egoism is always dangerous, but a certain amount of ambition and pride is essential to produce the driving force which forges ahead when the going is toughest. If one can find a man with ambition, who is proud of his accomplishments and is eager to excel, but who is humble in spirit and self-critical in outlook, then one has a very powerful combination indeed.

Aggressive, combative types are a menace.

When I first started interviewing men I was very susceptible to a display of enthusiasm. However, I have found that enthusiasm can be quickly damped and curiosity can soon be satisfied.

Without qualification I shall say that the first and most important requirement in an expedition man is that he shall love his job.

The second essential is unselfishness, which embraces thoughtfulness for others. The man who won't pull his weight, and slacks or is incompetent in his specialised job is highly resented.

Closely behind unselfishness I would place tolerance—tolerance of other men's views, other men's idiosyncrasies, other men's failings.

Optimism, I think, is important. Pessimists I avoid like the plague, also cynics. A sense of adventure and an avid curiosity are desirable but we have had good men who possessed neither.

Character, guts and "stickability" are basically essential, for a year is a long time and the difficulties which confront a man are many.

I draw no line regarding age. It is unusual, however, for a man past 40 to possess the necessary physical drive and energy we require.

There seem no particular arguments for preferring married to unmarried men. The married men are, on the whole, more stable and contented, but if anything goes wrong back home during their absence they worry badly and their morale suffers. It is risky to take newly married men, that is, men who have been married for less than a year, and I think it is a mistake for an engaged man to marry just before he leaves for Antarctica.

The man who has had a great number of jobs always arouses my misgivings when I interview him. I must beware of the man who cannot stick at any job for more than a month or two, and I must avoid the man who leaves behind him a broad pattern of failure in his endeavours.

One does not waste too much time on the man who wants to escape from insoluble marital complications, or the man with the life pattern of failure who desperately hopes that in his next job "things will be different". There is, however, the man who because of social deficiencies rather than defects in character has found civilised life in a modern city overwhelmingly complex. He believes that somewhere, away from it all, he could be a success. Often he is right.

In the simple life at an Antarctic station an escapist of the latter type, who is good at his job and amiable to his fellows, will earn their respect for his work and experience a sense of achievement in spite of his lack of social confidence. He will know what problems are likely to arise each day and will feel confident of overcoming them. He will find he is happy and contented and sure of himself.

After a year of this, our misfit from civilisation can be pardoned for feeling that he has found the secret of living and has solved the problem of his own personality. The inner strength that he has developed and the calm self-confidence that he has achieved he feels will never again desert him. Upon his return he will be able to look his friends and enemies in the eyes with tranquil dignity and his newly found sense of values will guide him through the cheap and tawdry maze which is modern civilisation. Or so he thinks! Within a few weeks of his return he will fall back hurt and bewildered to the state in which he existed before he went south. What he has failed to realise is that he has only solved the problem of living in a simple community. Generally speaking, he is not one whit better-equipped to cope with the complex society back home than he was when he left. It is not surprising that such a man, disillusioned and discouraged, will think nostalgically of his success and contentment with the expedition, and present himself on my doorstep some months later as an applicant for a further term down south.

Nevertheless, I know few men who have not profited considerably, in some measure or other, from a year at an Antarctic station. Most men, with the opportunity to commune in solitude with Nature in her grandest guise, experience moments of spiritual insight and understanding from which they derive some philosophical principles to guide them when they return to a normal existence.

DRUGS AND BEHAVIOURAL STUDIES

W. MAYER-GROSS, M.D.

News reports have recently mentioned the possibility of using lysergic acid and other drugs as weapons of war. This article deals with the potentiality of such drugs for mental therapy.

That drugs used in medicine may have psychological effects seems so obvious and commonplace, that it is surprising that scientific pharmacology has only recently turned its attention to these effects. The actions of sedatives, hypnotics, and analgesics were, of course, much studied in the 19th century; but sleep, narcosis, and pain were looked at from the neurophysiological angle with the abolition of awareness as the main aim. Little interest was shown in concomitant effects on the patient's feelings and personal experience. The same held true in "experimental pharmacology" where psychological or behavioural influences of drugs were, if possible, avoided—or neglected. If such influences were present they disturbed the interpretation of the physical effect of the drug, for instance, on the autonomic nervous system, that part which regulates the pulse, blood pressure, gland secretions, and so forth.

This attitude has entirely changed recently, mainly through the discovery of new drugs with almost exclusively psychological action and little or no influence on consciousness and the sleep-wakefulness mechanism. To understand the difficulties of investigation in this new field a few historical remarks are necessary.

Until the 18th century the mind (soul or psyche) was the domain of the priest, the magician, or the philosopher, but not of the doctor. Consequently substances such as alcohol, opium, hashish, coca, coffee, tea, and the numerous rarer drugs used in religious practices throughout the world aroused only a short-lived curiosity, chiefly as matter for anecdotes. The majority of these substances are mental stimulants. They make work, even physical work, appear easier, produce a more cheerful spirit (euphoria), and stimulate a play of fantasy and a deceptive feeling of strength. Some have social functions, fostering a pleasant forgetfulness of sorrows at the end of the day, facilitating social converse, or, as in opium and hashish, facilitating escape from reality into the riches of fulfilled wishes and dreams. It seems not improbable that the ascetic puritanical outlook of many scientists may have prevented their earlier scientific study. In fact, the first synthetic mental stimulant introduced (1935) into the official pharmacopoeas of the world, *amphetamine sulphate*, had been known for over twenty years to the pharmacologist, but only studied for its action on the autonomic nervous system. It was introduced as a remedy against attacks of narcolepsy (irresistible fits of sleep), but soon became popular because of its effect in stage fright and examination anxiety, as a pep drug in battle

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FIG. 1 (*left*). Charcoal drawing made 20 minutes after taking 25 μg. LSD. Condition normal. Another μg. LSD was ingested 40 minutes later.

FIG. 2 (*centre*). Charcoal drawing made 1 hour 25 minutes after the first dose of LSD (25 minutes after the second dose). Euphoria. The subject sees the model correctly but finds difficulty in transferring the correct proportions to the paper. His hand makes wide, uncontrolled, sweeping movements.

FIG. 3 (*right*). Charcoal sketch made 2½ hours after the first dose of LSD. The subject sees the outlines of the model normally, but very vividly and in changed colours. He takes great pains to draw correctly, but states: "My hand must follow the bold sweep of the lines. I feel as if my consciousness is situated in the part of my body that is now active."

FIG. 4 (*left*). Shortly after the third sketch. "The outlines of the model are normal but those of my drawing are not (Fig. 3). I pull myself together and try again: it's no good. I give up trying and let myself go at the third attempt" (Fig. 4).

FIG. 5 (*centre*). Shortly after the third and fourth sketches. "I try again and produce this drawing with one flourish."

FIG. 6 (*right*). Drawing in colour (tempera) made 2 hours 45 minutes after the first dose of LSD. Agitated. "The perspective of the room has changed; everything is moving . . . everything is interwoven in a network of colour. . . . The model's face is distorted to a diabolic mask."

stress, and the like. How much environmental and social factors enter into the use (and misuse) of this kind of drug, is shown by the widespread addiction to stimulating amines in present-day Japan, for which public control has become necessary.

Modern scientific study begins with Kraepelin, the father of modern psychiatry. He started in 1892 a large series of experiments on normal and abnormal persons using the ideas and methods of experimental psychology recently established by Wundt in Leipzig. Kraepelin studied the effects of alcohol, morphia, caffeine, and other sedatives and stimulant drugs on skills such as adding, learning by heart, skilled movements of the fingers, and so on. The results were especially valuable in the case of alcohol, and also threw light on the psychology of work, but had little enduring influence on the development of either pharmacology or psychiatry. The same can be said of Kraepelin's move towards a systematic study of those drugs which can produce temporary pathological symptoms, not unlike the disturbances of schizophrenia or manic-depressive illness, in perfectly normal people—so called "model psychoses". Mescalin, the best known of these psychotomimetic substances, was originally used by Mexican Indians in their religious ceremonies. It was grouped by the pharmacologist Lewin with nitrous oxide, hashish, and hyoscine among the "Phantastica", and they were subjected to a large series of experiments in Germany in the 'twenties. People who took these drugs were asked to describe their experiences throughout in detail, and it was hoped that the self-observation of these intoxicated subjects would provide a better understanding of psychiatric patients. This wave of interest never penetrated beyond the descriptive analysis of psychological phenomena. The gulf to be bridged between the mental experience and neurophysiological processes seemed to be much too wide. And even if we today know a bit more of the working of certain cerebral functions, which can be analysed electrically, this gulf still demands our respect and careful handling. However some work in 1943 reawakened interest.

LSD 25

During the investigation of the constituents of ergot, Hofmann discovered by chance a new substance with a mescalin-like effect. Psychiatrists and pharmacologists were slow in grasping the significance of the discovery of lysergic acid diethylamide (LSD 25); but the interest in it gathered momentum as part of the increasing concern with drugs of psychological effect. Its clinical use is negligible. LSD 25 differs greatly from mescalin in chemical structure, it is effective in remarkably small amounts (0·03 to 0·06 mgm. by mouth is enough). Its influence on the subject's mood and well-being is perhaps more marked than that of mescalin though the sensory phenomena produced are almost identical.

Figs. 1–9 give an impression of the changes caused by LSD intoxication in the artist, L. Mátéfi. He undertook to sketch a portrait of the same model before taking LSD 25 and at intervals of roughly an hour after taking 100 μg. of the drug by mouth. The series of portraits shows the increasing motor uncertainty, the progressive distortion of visual perception, and the expansive mood as expressed in the flowing lines used in Figs. 5–7. In Figs. 8 and 9, the effect is beginning to wear off and there is a gradual return to normal.

The first analysis of the symptoms by Stoll followed the pattern of the earlier mescalin experiments, with the result that he classified the picture of the intoxication as belonging to the "organic psychosyndrome" of E. Bleuler. The importance of self-observation in "model psychoses" was, however, recognised and the evaluation of self-observed experiences by both patients and normal subjects reconsidered. It was pointed out that two factors matter:

First of all the veracity and reliability of the subject must be considered, his sensitivity for body feeling and inner experience. (This is an entirely different form of truthfulness from that which prevails in reporting external experiences.) Secondly, personal temperament has to be taken into account. Mildly hypochondriacal people with a certain amount of introversion are probably the best observers in

this field. Extraverts have to be trained for this type of observation, and even then are liable to deceive themselves and give a biased account of their experiences, coloured by the wish to impress the experimenter, or by an ideal picture they have of themselves. Probably the worst witnesses in this respect are extravert hysterics. If self-observation is to be used profitably in the analysis of the psychological effect of drugs, an urgent requirement is the development of an appropriate epistemology, using the knowledge gained by the phenomenological schools of psychology, to clarify the common errors and sources of deception.

The action of LSD 25 has become one of the main topics of psychopharmacology, and attempts at quantitative studies (counting the frequency of occurrence of symptoms in groups of people in the various phases of intoxication and applying a number of psychological tests) were made on a large scale by American psychologists like Abramson, with the help of volunteers of various kinds. At Lexington, Kentucky, where the United States Public Health Service maintains a special research institute for the study of problems of drug addiction, Wikler and Isbell (1955) experimented with narcotic addicts as subjects.

They tried to elicit their experiences by questionnaires based on earlier accounts of self-intoxication, which had to be filled in during and after taking the drug. One of the most interesting findings was that tolerance for LSD 25 develops very rapidly as is already evident after three days' regular medication. When it had fully developed, four times the standard dose did not restore the original vividness of symptoms. After stopping the LSD 25, tolerance was lost equally rapidly, so that the person again became fully sensitive to the stuff.

Another interesting discovery was the degree of specificity shown. LSD 25 is one of four stereoisomers, but the only one to be psychotomimetic. The other three are without psychological effect. This is of course often found when drugs are carefully studied in biochemical and pharmacological laboratories, and LSD 25 has given rise to an enormous amount of laboratory research also. It is known that a number of hormones found widely in the body also occur naturally in some parts of the brain. Two such are serotonin and noradrenelin. It is supposed that they act as transmitter substances: that is, that one nerve cell excites another by liberating a little serotonin or noradrenelin in its vicinity. When laboratory work showed that LSD 25 was antagonistic to some of the actions of serotonin on smooth muscles it was suggested that antagonism to the natural serotonin of the brain might be the physical basis of LSD 25's mental effects. But experiments in man do not bear this out.

The apparent resemblance of some features of model psychosis to acute schizophrenia led Gjessing, in 1935, to suspect that a mescalin-like substance might be produced as an abnormality in the bodies of schizophrenics—but it was never demonstrated. The idea was revived and is still ardently defended by a group of workers in Canada (Hoffer and Osmond 1954). They pointed to the close chemical similarity of mescalin and noradrenaline and suspected "Adrenochrome", an intermediary product of adrenaline metabolism, as a "psychotomimetic" agent. So far this hypothesis also has not been substantiated.

EFFECTS ON THE MENTALLY ILL

So far we have been discussing the effects of drugs on normal people. But in the last ten years two drugs have been discovered which modify chiefly the mentally sick, and this is an independent story.

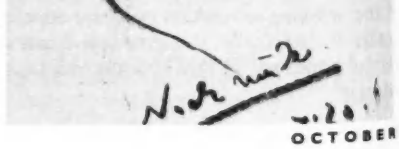
Phenothiazines introduced into pharmacy for their anti-

FIG. 7 (*left*). Pen and watercolour drawing, 4 hours 25 minutes after the first dose. Euphoric mood, intoxication less marked. The subject attempts to draw a portrait similar to his first one. "If I am not careful, I lose control of my movements."

FIG. 8 (*centre*). Crayon drawing, 5 hours 45 minutes after the first dose of LSD. "It is probably because my movements are still too unsteady that I am unable to draw as I normally do. . . . The intoxication is wearing off, but I can both feel and see it ebbing and flowing about me (now it only reaches to my knee); finally only an eddying motion remains."

FIG. 9 (*right*). Charcoal drawing, 8 hours after the first dose. The intoxication has now worn off, apart from a few small waves (for example, sudden distortion of faces from time to time). The subject feels bewildered and tired. "I have nothing to say about the last drawing; it is bad and uninteresting."

(All illustrations from "Triangle", the Sandoz Journal of Medical Science)



histamine effect had two side-effects: some were anti-emetic and a few made the taker sleepy. Laborit and other French workers seized on the latter property and applied it in anaesthesia where it seemed to potentiate barbiturates and other hypnotics, especially under conditions of lowered body temperature. This proved to be a successful introduction and revealed the remarkable and versatile use that could be made of chlorpromazine. The mental effect in border-line cases (normal subjects and neurotics) proved very disappointing; but the results in the difficult, aggressive, resistive, and violent cases of chronic psychosis, in just those patients who fill the wards of large under-staffed and over-crowded mental hospitals, were astounding. Another recently rediscovered drug was a herbal remedy, Rauwolffia, from the treasures of ancient Indian medicine. It was always regarded as a remedy for high blood pressure and "insanity", and has similar, though less reliable effects. It was analysed chemically recently, and its chief constituent, reserpine, has proved an important addition to the psychiatric pharmacological armamentarium.

In neither case is it known how the psychological effects come into being. Attempts to find their point of attack on the metabolic cycle of the brain cell, or to localise their action in certain parts of the brain have so far had very little success, though discovery may be just around the corner.

It seems theoretically remarkable that both drugs, in spite of their very different chemical constitution, have, in larger doses, the same side-effects: they produce a transient Parkinsonian appearance in the patient, a characteristic stiffness in certain muscles. Moreover, Rauwolffia medication has sometimes another side-effect, since it may on its own bring about a more or less severe mental depression. That these drugs have not only extinguishing and abolishing effects, but also can produce psychiatric symptoms, brings them near to the psychotomimetics and to model psychoses.

One of the difficulties in research on these drugs is the impossibility of repeating their psychological actions in the animal, and equally of testing under laboratory conditions those with potential influence on human psychoses or other mental abnormalities. Nevertheless, there are certain attempts to overcome the difficulties. Behavioural pharmacology has made use of the Pavlovian conditioning techniques of Skinner and his school which enables the worker to establish a base line of behaviour of say: a pigeon, a rat, or a guinea pig. The animals have learned to provide themselves with food, or to avoid an electric shock, or to respond to a base line from observation of the normal. Apart from the Skinner school of conditioning, most drugs are assessed by their general sedative action in deepening pre-existing narcosis, or by their protective influence against artificially induced epileptic fits, or against the effects of other stresses on bodily functions, or on sham rage. In other words the base line is in most cases some abnormal or exceptional condition. Very few of these methods are satisfactory.

SOCIAL RELATIONSHIPS AND GROUP LIFE

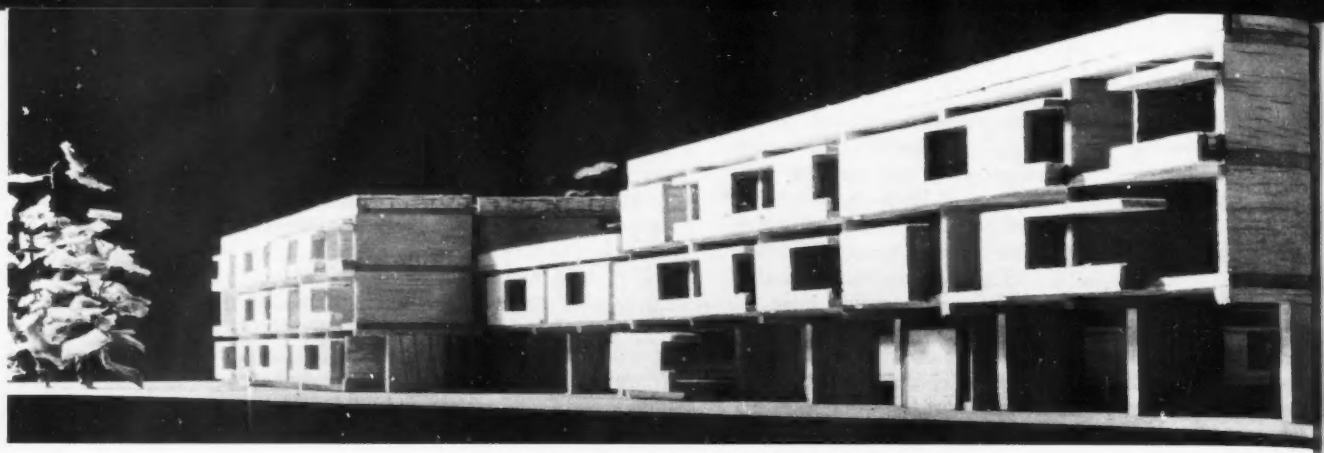
The considerable individual variability of reaction makes it the dream of the experimenter to test his drugs on animals and controls from the same inbred litter. But even this ideal has recently been somewhat spoiled by behaviour physiologists who found that rats learn their way in a maze very much better when they are stroked daily and regularly by the experimenter from the day of their birth. They were far superior to their sibs who had been separated from their mother and never stroked.

M. Chance reported that the stimulating effect of the same dose of amphetamine was increased nearly ten times by keeping the treated mice in groups of ten instead of singly in cages. Thus social relationships and group life are not without influence on psychological drug effects in animals, and therefore how much more so in man!

In this connexion two points arise. It seems appropriate to remember the introspective origin of most psychological terms. All that we observe in the behaviour of animals, under such names as aggression, fear, rage, and anxiety depends for its understanding on an observer who himself experienced these feelings. It would be impossible to explain or define curiosity, desire, approval, or conflict from outside observation alone. Equally, such concepts as reward or punishment, acceptance or rejection could hardly be understood by someone who has never felt the corresponding attitudes. Yet the behavioural physiologist, try as he will to avoid anthropomorphic interpretations, cannot do without these or similar psychological terms. Even if he re-defines them, he cannot divest them of the halo of meaning which comes from their introspective origin. If, as seems to be the case, it is not possible to interpret animal behaviour without using a vocabulary based on psychological experience, it behoves us to recognise the fact explicitly.

A second point is concerned with those relations between living beings which are independent of speech and language. It can hardly be doubted that there exist between animal and animal, and also between man and animal, forms of understanding and speechless communication, by means of gesture, mime, and other expressive movements, which for want of a better name have been called "physiognomic". Communication of this kind certainly occurs in everyday life, and there is no reason to think that it is barred in the experimental animals of our laboratories. Straus (1935), speaking of "symbiotic" understanding, contrasts the poverty of our knowledge about the means of expressive communication with the certainty, richness, and differentiation of our reactions.

As we can see the doubts are as numerous in animal experiments as in human tests. As a kind of guiding principle in the search for psycho-pharmacological tasks, in human experiments the holistic idea, the search for a drug changing the behaviour or the personality as a whole, should I think be thrown over. Pharmacology should first of all aim to abolish those symptoms which we know can be produced by action of a drug. Depression, anxiety, manic excitation, emotional blunting, hallucinations, depersonalisation, and catatonic motor behaviour are such symptoms; from the chemical substances which release them, their antagonist should be developed. Equally the various layers of consciousness, especially those not easily accessible to direct enquiry, hidden from the patient's own self-scrutiny, appear a worth-while object of pharmacological effort.



CHURCHILL COLLEGE

SIR JOHN COCKCROFT

A continuing memorial to Sir Winston Churchill and a contribution to one of the most important needs of Britain.

Churchill College has now received the Royal Charter. About thirty research students—the first to be admitted—will enter on October 1.

The College was first conceived in 1957 as a continuing memorial to Sir Winston Churchill; it was also to contribute to one of the most important needs of our country by increasing the number of first-class graduates in science and technology trained in the Cambridge tradition.

Sir Winston Churchill became Chairman of a Board of Trustees which consisted of Lord Chandos, Sir Alexander Fleck, Lord Godber, Lord Tedder, Lord Weeks, and Mr W. J. Carron representing the industrial world, together with the Master of Trinity, the Master of Christ's College, the Provost of King's, Sir Alexander Todd and Sir John Cockcroft representing the University. Lord Knollys formed an Appeal Committee with the object of raising £4·5 million for buildings and endowment and obtained strong support from British industry, commerce, and scientific foundations. Over £3·5 million has been received so far.

The foundation of colleges has in the past been one of the greatest contributions to the cultural and scientific life of Britain. A single college, Trinity, has been the home of Isaac Newton, Clerk Maxwell, Rayleigh, J. J. Thomson, Rutherford, Henry Dale, Aston, Bragg, Adrian, Hardy, and innumerable other outstanding scientists and mathematicians. The 16th century was enriched by the foundation of five Cambridge colleges; the 19th century by only one men's college, Selwyn, and two women's colleges. The 20th century has made a recent start by the foundation of the women's college of New Hall, of Churchill College and of a reincarnation of Fitzwilliam House, which is to become a fully fledged college. The foundation of the new colleges will allow the number of students in Cambridge to be increased by about 10%. More important than the additional numbers is the expectation that we will thereby increase the number of potential leaders of science, industry, commerce, and administration of the country.

The trustees decided that the new college should have a strong scientific and technical bias, so approximately 70% of its students will be trained in science and technology and 30% will read arts subjects. Furthermore, about 30% of its students will, if possible, be post-graduates working either in research or carrying out a course of post-graduate studies continuing up to one year. The need for courses of this kind was particularly stressed by industrial representatives and the foundation of the college will enable more students to be admitted by the University for such courses. The trustees also envisage that the college should ultimately consist of 540 undergraduate and post-graduate students and 60 fellows. The college will admit its first undergraduate students in October 1961, but it will probably take five or six years before the full numbers are achieved, the exact time depending on the progress of its main buildings and on obtaining the funds required for the complete college. The college may thereafter include 250 undergraduates studying mathematics, natural sciences, and engineering. The college will not have its own laboratories since formal teaching is carried out by the University which has recently expanded its accommodation in engineering, chemistry, and chemical enginering, and is planning an expansion in other scientific subjects, including physics and metallurgy, mathematics, and biochemistry. The responsibilities of the college are to house the students, to provide the tutorial instruction to supplement the formal lectures of the University and to provide the libraries, common rooms, lecture theatre for general lectures, and athletic and other general activities of student life. The college will therefore ultimately have a staff of thirty to thirty-five tutors, directors of studies, and college lecturers appropriate to the number of its students, together with thirteen research fellows, some professorial fellows, three overseas fellows, coming for short periods, and a number of "extraordinary fellows". The college has so far

Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S., 1951 Nobel Laureate for contributions to Physics, is Master of Churchill College, Cambridge.

made about half this number of appointments. Its extraordinary fellows consist of Sir Charles Snow, Mr. John Oriel (who will help the college with his great experience of industrial education), and Dr. Francis Crick, a member of the Medical Research Council Unit for Molecular Biology. In general, the college, thanks to the wisdom of its founders and the drafters of its statutes led by the Provost of King's, will have a more varied body of fellows than has characterised earlier colleges, and this will no doubt stimulate changes in the older foundations.

The college buildings are being planned ultimately to accommodate all unmarried students and fellows, and a block of twenty flats has been built at the western end of the site to accommodate married visiting research fellows and students. A very fine site of forty-two acres was provided on the Madingley Road running from Storey's Way to the Observatory grounds. The main college buildings will be at the eastern end and the main entrance will be from Storey's Way. Between the main buildings and the flats will be the playing fields, including five winter pitches for football and hockey, together with tennis courts and, ultimately, we hope, a covered swimming-pool if a donor can be found.

The trustees invited twenty architects to compete for the planning of the college, and Messrs Richard Sheppard, Robson and Partners were chosen in July 1959. Since that time the block of flats has been nearly completed by Messrs Bernard Sunley and Sons, and will be partially occupied this October. The playing fields have been levelled and drained and seeded, and many trees have been planted on the perimeter, and a start has been made on the foundations for the first block of residential accommodation in the main college. This second phase of college buildings will include the essential services such as the central boiler-house—the college is to be centrally heated—and the Master's Lodge. Design work is proceeding on the third phase, which will include the hall, kitchens, common rooms, and libraries, together with the necessary rooms required for communal life.

The college is planned to have its residential accommodation in ten courts, each housing about fifty members of the college in three-storey buildings. The small courts are arranged round an open space, and it will be possible to walk under cover from one court to another. The buildings are to be in brick with some artificial stone facings, with teak window-frames and copper flashings, and possibly copper roofs. The courts are designed on a staircase plan with service rooms providing cooking facilities, cleaning facilities, baths, showers, etc.

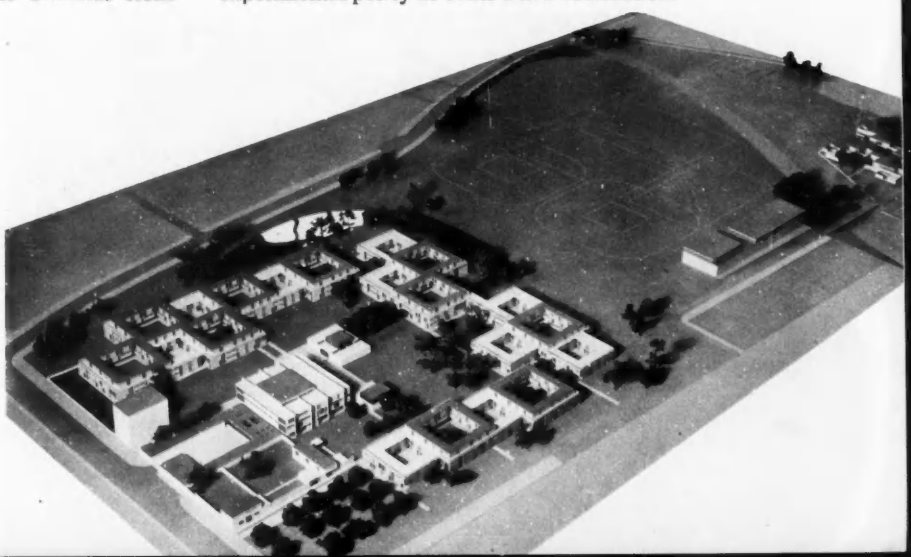
We hope that the college will make its contribution to the general education of its members in the traditional, informal Cambridge way by providing facilities and opportunities for general lectures, college societies, music, plays and films. The Brendan Bracken Library, open twenty-four hours a day, will contain current books of reference, and the Bevin Memorial Library will be a general library for senior and junior members.

We intend to do what we can to stimulate and help the post-graduate studies of the University and we have a small group of eminent industrialists interested in education advising us on this. We have made a start by offering to help the University by providing teaching staff for two such courses.

At the same time some reshaping of post-graduate education and training for research is going on in university departments, since it has for some time been realised that they ought to give more formal courses of post-graduate lectures in at least the first year of a research training. So, the University may well provide new post-graduate courses of study suitable both for students going on to take a Ph.D. degree and for students coming for refresher courses in industry.

The college can also to some extent influence education policy by its admissions policy. We have a great deal of sympathy with the desire to reduce excessive specialisation in schools and we intend to admit most of our undergraduates through a general entrance examination common to a group of colleges. In this examination, considerable weight will be attached to the general papers, and we hope that this will encourage schools to maintain teaching in arts subjects for scientists and science for arts students. A great deal of the blame for excessive specialisation has been placed on the entrance scholarship system of the colleges, with its extremely high standards. We are now considering our policy on scholarships and have already decided that some of our scholarships will be awarded at the end of the first year of residence.

We do not have a fixed blueprint for the educational policy of the college but will pursue an evolutionary and experimental policy as befits a new foundation.



Proposed plan. Residential quadrangles surround cluster of buildings that include the assembly hall, library, reading-room, and dining-hall. Married quarters beyond the playing fields—the only buildings completed so far—will be used for all College activities by the incoming group of research students.

RECENT DEVELOPMENTS IN GEOPHYSICS

ANGELA CROOME

A report from the triennial meeting of the International Union of Geodesy and Geophysics in Helsinki.

EARTH'S RESONANCE GIVES CLUE TO INTERNAL STRUCTURE

The Chilean earthquakes which reached a peak on the afternoon of May 22 with a magnitude 9 shock were one of the worst natural disasters of this century, resulting in the loss of at least 5000 lives and the destruction of 100,000 houses. The upheavals caused a sensation among scientists for they confirmed the theory that sufficiently great disturbances within the earth can make it "ring like a bell". The frequencies measured checked those found recently from highly complex theoretical calculations. These calculations, incidentally, also confirmed the frequency measured during the great Kamchatka earthquake of 1952. According to some geophysicists the agreement of theory and measurement has established the identity of the main structure of the Earth's deep interior beyond all reasonable doubt. Prior to this, several models of the planet's internal structure were held in equal respect, although they varied considerably. Theoretical calculations on the natural vibration of the Earth using the so-called Bullen Model B have been vividly substantiated by this summer's events.

Angela Croome, a regular contributor to DISCOVERY, *has written extensively on IGY and post-IGY activities.*

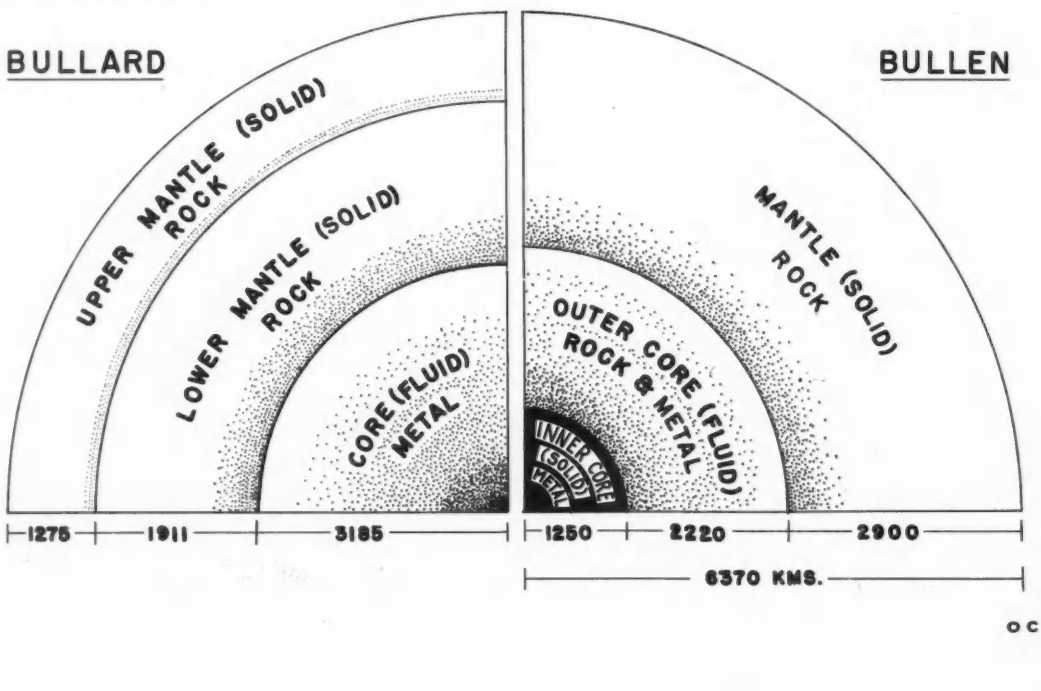
The resonance of the Earth was first detected by H. Benioff of the California Institute of Technology at the time of the great Kamchatka disturbance. Using a newly developed seismic instrument of great sensitivity which measured rock strain, he observed two ultra-long frequency waves with periods of 57 and 100 minutes. These measurements were looked on with considerable reserve at the time because there was no supporting evidence from independent observations and no theoretical work on this planet's interior that was sufficiently advanced to illuminate the interpretation.

Using various models of the Earth's internal structure, C. L. Pekeris of the Weizmann Institute in Israel set to work on the highly complex mathematical problems involved in the theoretical determination of the natural resonance. Only the model proposed by K. E. Bullen of the University of Sydney gave oscillation frequencies that came close to those measured by Benioff. Pekeris calculated a natural period of 53·4 minutes with an overtone of 35·6 minutes.

The main Chilean earthquake of last May 22 produced a host of vibrations. Two laboratories in the United States, using quite distinct types of apparatus, observed ultra-long waves with periods of approximately 50 minutes, agreeing well with the 53·4 minutes calculated by Pekeris. One of the groups, led by Benioff and Press at California, made its measurements with a rock-strain gauge that recorded changes in the horizontal direction, the other group, under Slichter, at the University of California (Los Angeles), used a gravity-meter which recorded vertical vibrations. Both recorded 50-minute waves.

What does this imply about the inner

FIG. 1. Models of the Earth's interior: The Bullen model (*right*) compared with Sir Edward Bullard's most recent model. Bullen's model was the only one that satisfied the elaborate analysis carried out by Pekeris' group on the WEIZAC high-speed electronic computer. The Bullard model (*left*) was second best. Both models are tentative and new data are likely to introduce further modifications.



structure of our planet? The natural frequency of any body depends broadly on its dimensions and density. The density, of course, is a function of the material of which the body is composed. We know the size of the Earth but precise measurements of its density have only been possible by direct means to a depth of a few miles, up to the present time. Beyond this depth, the density can be determined only by indirect means, by seismic and other techniques. These give a fairly consistent picture but the uncertainty increases sharply with depth. What lies at the Earth's core is still a matter of hot dispute. There is general agreement that the planet's structure is not homogeneous—that it is made up of sharply contrasting layers with different chemical compositions, temperatures, and density. Three main regions are generally accepted; going from the surface towards the centre, these are: the Crust, which is very thin and comparatively light; the Mantle, a thick layer that is considerably more dense; the Core, very dense, extremely hot, under great pressure, and probably in the liquid state. When an attempt is made to differentiate beyond this, agreement ends.

The combination of Pekeris' work and the Chilean earthquake data gives impressive weight to Bullen's model, shown diagrammatically in Fig. 1. This model has four regions rather than three—a crust, a mantle, an outer core that is liquid, and an inner core that is solid. According to Bullen, the specific gravity of the mantle rises from 3·3 near the crust to 5·5 at the mantle-core interface. It then jumps to 9·5 and reaches 11·5 to 12 where outer and inner core join. The specific gravity of the inner core is now thought to be as high as 18 and this figure has received some support from Pekeris' calculations.

The increase of pressure with depth is even more remarkable. At the bottom of the mantle, Bullen estimates a pressure of 1¼ million atmospheres; at the centre, 3½–4 million atmospheres.

THE MULTIPLE DYNAMO CORE

Another unsolved curiosity of our planet is its magnetic field. The principal source of this magnetism seems to be its fluid core, operating as an enormous dynamo. Geomagnetic experts at the IUGG meeting tended to agree that there was a double and possibly a multiple dynamo system in the core.

This conclusion was based on theoretical and laboratory work that has been going on independently for some years in Britain, Japan, and the United States. There does not seem to be any other way of accounting for the anomalies in the Earth's field with time.

MAGNETIC FIELD REVERSALS

Numerous observations by various university teams of the past magnetic history of surface rocks from widely separated localities show that the Earth's magnetic dipole somersaulted 3 million years ago and then reversed polarity again about one million years ago. A 600-metre thick layer of magnetised rock that has been studied in detail by scientists from Tokyo Geophysical Institute reveals the stages of a total field reversal. When the causes of the now well-substantiated shifts become clear, the precise mechanism that gives this planet a magnetic field in the first place will be firmly established. The steady westward drift of the North magnetic pole during the past century may be part of another reversal.

UPPER MANTLE PROJECT

Our personal planet becomes more fascinating as one better appreciates its mystery and the many uncertainties that still remain about its nature. Due to the impetus imparted to deep earth studies by the use of high-speed electronic computers for solving the enormously complex theoretical calculations relating to the internal structure, these studies have now reached an explosive phase of expansion. This gives special point to the important proposal for an international Upper Mantle Project that was put forward at the IUGG meeting by its new president, Soviet Academician V. V. Beloussov, a man who is respected throughout the world for his leadership of the massive Soviet IGY programme. His proposal was adopted at the final plenary session and is now being referred to the scientific academies of the 60 member countries for comment and financial support. If it is strongly endorsed, it is likely that a special committee of the International Council of Scientific Unions will be set up to co-ordinate the work on the lines of the IGY committee and the special committees on the Antarctic, oceanography, and space that were set up after the IGY. SCAR (the Special Committee for Antarctic Research) endorsed it. Beloussov's Upper Mantle Project is an interdisciplinary one that will co-ordinate the work of seismologists, geodesists, oceanographers, vulcanologists, and scientists concerned with geomagnetism.

Some of the fundamental questions about the Earth's nature and evolution that it should help solve are:

1. Is the planet gradually growing bigger as a result of interior heating? Beloussov believes it is, although Dr. Tuzo Wilson, the past IUGG president, thinks it is shrinking. At the Helsinki meeting, the "expansionists" were, on the whole, in the ascendent. An important theoretical paper by the Hungarian geophysicist L. Egyed indicated the Earth's radius is increasing by 1 mm./yr. and grew at a more rapid rate earlier in geological time.

2. Are the continents eating up the sea or is the sea swallowing the land? Recent observations suggest that one or the other is happening over the millennia but it is not clear which. Beloussov is personally of the opinion that the oceans are growing at the expense of the land. The granite layer under the sea is much thinner than that under the land—this is one pointer. There is evidence that some of the offshore seas such as the Bering Sea and the Sea of Japan are young seas that are only a few million years old. The Pacific Ocean is now known to be a mile deeper than it was 50 million years ago.

3. Why do earthquakes occur and what is the cause of volcanoes?

Such enterprises as the American Project Mohole, for which a test drill off Guadaloupe is now definitely scheduled for this coming January, will fit happily into this overall project.

The argument for an Upper Mantle Project could hardly be put better than it was by Beloussov when he said in the preamble to his proposal: "After each journey into space, man must return to this old Earth. Yet we still do not know as much about the nature of our planet below a few kilometres under our feet as we do about cosmic space thousands of kilometres away. This seems to me rather shaming and it is our duty to begin an internationally organised campaign for scientific conquest of the Earth's depths."

AVOIDING *TSUNAMI* DISASTERS

A number of the Chileans who perished this summer as a result of the Chilean earthquake were drowned rather than buried. They were victims of the *tsunami** that occurred after the largest shock struck at 16.00 hours on May 22. In addition, nearly 200 people died in Japan and Hawaii when this wave pulsed across the Pacific Ocean at 400 m.p.h. and hit the Japanese south-east coast 23 hrs. later. A *tsunami* warning issued in Hawaii was disregarded by some people and failed to reach a small number of others. A warning issued along the Pacific coast of Japan

* This Japanese word is the only expression in existence for the particular variety of large destructive sea waves engendered by upheavals of the Earth's crust.

as a result of a delayed message recording the arrival of the wave at Hawaii was too late; two minutes after the warning was given the wave struck.

An exhaustive discussion of every aspect of this disaster and consideration of the nature of *tsunamis* and what can be done to improve the Pacific warning system took place at this August's triennial meeting of the International Union of Geodesy and Geophysics at Helsinki.

As a result of these discussions and of others with the World Meteorological Organisation, the present *tsunami* warning system for the Pacific seaboard is to be completely revised. The shortcomings evident from this summer's events were shown to be due partly to lack of knowledge about the exact nature of this phenomenon and how it is produced, and, secondly, to the fact that warning systems in the Pacific have been operated on a national basis with poor liaison and communications between the different national centres. Because of the poor liaison across the Pacific, the Japanese, with the most efficient warning system in existence for locally produced waves had no idea of the size of the wave that struck Hilo in Hawaii until it was about to inundate the Japanese coast. The water-level surged 10 ft. above the normal high-tide mark.

The Chilean seaboard suffered the worst; the damage was so severe along 200 miles of the southern coast that almost all useful evidence about the disaster was swept away with the waters. Most of the small fishing villages scattered throughout the area were wiped out without a trace. The visual evidence remaining when the inspection teams arrived indicated the magnitude of the wave or waves. Debris stuck in trees 36 ft. above sea-level showed the wave was at least this high. There was a considerable change in the coast line in parts of southern Chile as shown in the photographs opposite.

Readings from the distant Chilean tide-gauge stations to the north proved highly misleading. On May 22 the average increase measured was only 1 metre. The principal station at Valparaiso registered only 66–77 cm. (see Fig. 2). An amplitude increase of this order was no cause for alarm on previous occasions. It is now supposed that the large peninsula that juts out into the Pacific north of the Golfo de Peñas placed the northern Chilean tide-gauges in the shadow area of the *tsunamis* and so masked the effect.

The upshot of the Helsinki meeting was that it remains completely unclear exactly how substantial *tsunamis* develop. Do they result only when a resonance is set up in the water with a normally occurring wave- or tide-pattern? Some large earthquakes produce *tsunamis*; others do not. Is an undersea upheaval a necessary additional prerequisite? Documentation on *tsunamis* of the past would help to elucidate these problems. A systematic search for such material is to be undertaken.

Other practical steps to be taken as a result of the Helsinki meeting include the extension of the present warning systems and the co-ordination of these on an international basis. The U.S., the U.S.S.R., and Japan have agreed to collaborate in issuing predictions and warnings in the future and nine other countries in the Pacific will join in the observational network. A working group of scientists has been established to make recommendations that will certainly propose an increase in the number of seismic and tide-gauge stations around the Pacific. The density is unsatisfactorily low in South America and a large gap in the network exists between South America and Hawaii, although suitable island sites exist for observation stations.

Since many stations record either water level changes or seismic activity, not both, observers do not always realise when they should be ready for quick action. This was the case at the Chilean tide-gauge stations where no unusual activity was observed for some hours after the main shock. Steps will probably be taken to have both sets of measurements made at all stations.

The first thing to collapse when there is a severe earthquake is the communication system through which alerts and information must be channelled to the nerve centres of the warning network. Automatic telemetry of records would greatly improve data transmission, and avoid the delay that can occur through conventional links. The delay in passing alerts overseas through the already oversubscribed commercial radio networks will be avoided by the use of the World Meteorological Organisation's high-speed communications network.

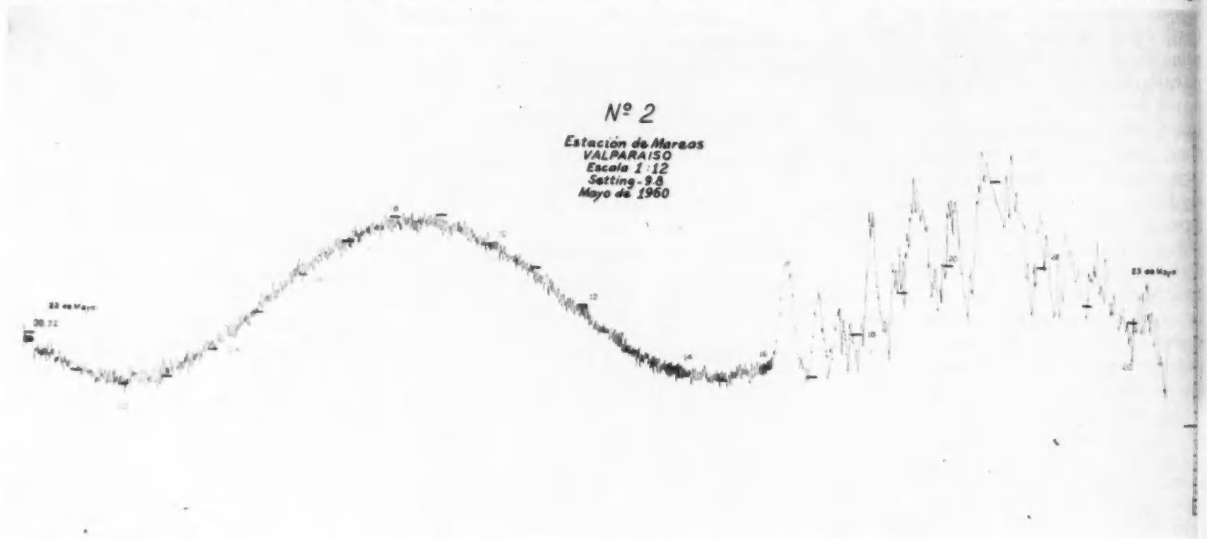
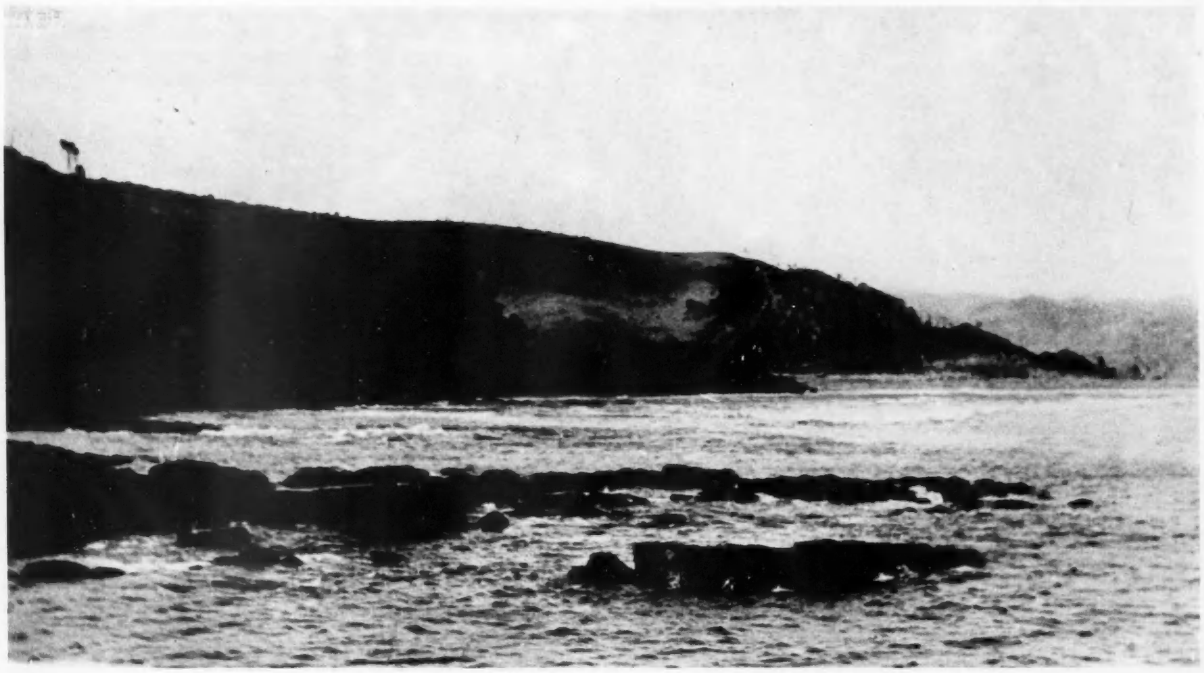
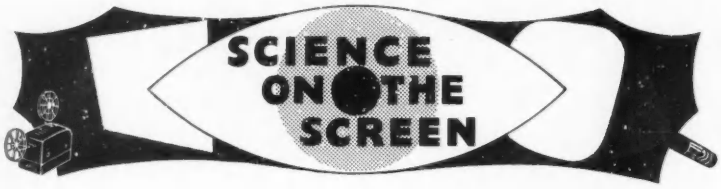


FIG. 2. Tide-gauge record from Valparaiso, Chile, on May 22, the day the main shock of the Chilean earthquake occurred. Record shows the normal ocean-tide on the Pacific coast with the onset of the *tsunami* superimposed at 16.00 hours.

FIGS. 3 & 4. Paired pictures showing subsidence off the coast of Southern Chile associated with this summer's violent earthquakes. The first view (*above*) shows a section of the shore before the earthquake occurred. Lower photograph gives the same view as it appeared in June, at the same phase of the tide. The Chilean scientist who reported to the Helsinki meeting said the newspaper reports of coastal subsidence were much exaggerated but "sufficiently impressive" for the inhabitants of the area.

(Photographs and chart from Dr Cinna Lomnitz, Instituto de Geofisica y Sismologia, Universidad de Chile)





European Co-operation for Scientific Films

A major project in international co-operation in science education is to be launched as the result of an agreement signed between the Minister of Education and OEEC.

The project, which is the first of its kind in this field, will consist of a series of films aimed at stimulating the interest of young people in scientific subjects and made by a number of national organisations concerned with the promotion of school films. The organisations are: The Educational Foundation for Visual Aids (United Kingdom); Institut Pedagogique National (France); Institut for Film und Bild (Germany); Statens Filmcentral (Denmark); Statens Filmsentral (Norway); Nederlandse Onderwijs Film (Holland).

Each of these organisations will make one film in an agreed series. The contribution of the United Kingdom will be a film on *Faraday* and the others are: *The Atomic Age* (Denmark); *Fight Against Bacteria* (France); *Discovery of the Rare Cases* (Holland); *The Story of X-Rays* (Germany); and *The Story of Electrochemistry* (Norway). In the production of these films, which are intended for the middle forms in secondary schools, there will be a full consultation between the countries concerned.

Early discussions revealed that in science teaching many countries faced common problems, and it was agreed that the most effective and economic contribution would be through co-operation and the production of such an international series as this.

The scheme, initiated by the United Kingdom, received the full support of the national organisations represented on the International Council for Educational Films. It has been made possible by financial help from OEEC which is contributing half of the cost, the remainder being provided by the national organisations already mentioned.

The project will be organised by the Education Foundation for Visual Aids which will also be responsible for the production of the United Kingdom film. When complete, the films will be available to all schools in the member countries of OEEC.

RESEARCH FILMS FROM GLAXO LABORATORIES

The Griseofulvin Story—How the antibiotic Griseofulvin was discovered and developed in Britain 1939–59.
16 mm. Colour. Sound. Running time 21 minutes. Produced for Glaxo Laboratories Ltd, under the supervision of Mr F. Woodward, by Cinechrome Films. Script and Direction by Bruce Campbell. (*Available on free loan to Medical and Scientific audiences from the Public Relations Service, Glaxo Laboratories Ltd, Greenford, Middlesex.*)

This is a well presented straightforward, down-to-earth, historical scientific documentary. It shows the discovery and development in Britain of an antibiotic for use in cases of fungus infections in the skin. It covers the work of 21 years.

When there are no appropriate visuals —as of the original work of Raistrick, Oxford, and Simonart, who isolated the substance from a penicillium culture in 1939—they show the building where the research took place. This method is quite effective.

The way in which the Glaxo Research Laboratory at Stoke Poges became interested in griseofulvin as a fungicide and developed it for use against fungal diseases of plants is clearly shown. The next stage was to develop methods of production on a sufficiently large scale to make it available commercially. Eventually, after the Ministry of Agriculture had approved it, it was produced for market gardeners. Dr Gentles, a medical mycologist at Glasgow University, and the workers at the Glaxo Laboratory experimented with its use for animals and man.

It proved disappointing when used externally. But when administered orally it was highly successful. The film shows by extracts from papers read by doctors and clinical examples how griseofulvin has spread throughout the world and is now used in America, and as far away as the Fiji Islands. The photography throughout is clear and uncluttered. There are no unnecessary gimmicks in the background and, as far as possible, we see the details of what is happening. The commentary is well spoken and although, of course, it uses medical and scientific terms where required, the rest of the English is absolutely simple and straightforward. This is a welcome change from many scientific films which crowd the sound track with the longest and most obscure words possible.

This is the fifth of the films produced by the Glaxo Research Laboratories; the Company is to be congratulated on keeping them strictly factual and not striving unduly for effect.

Longer Life for B.C.G.—The contribution of Research to the Manufacture and Standardisation of Freeze-Dried B.C.G. Vaccine.
16 mm. Colour. Sound. Running time 15 minutes. Produced for Glaxo Laboratories Ltd, under the supervision of Mr F. Woodward by Cinechrome Films. Script, and Direction by Bruce Campbell. (*Available on free loan to medical and Scientific audiences from the Public Relations Service, Glaxo Laboratories Ltd, Greenford, Middlesex.*)

This film is a report on one of a series of research and development projects carried through at Glaxo Laboratories.

Early this century a strain of bovine tubercle bacillus was sub-cultured by the Frenchmen Calmette and Guérin. They worked for thirteen years to produce an attenuated strain suitable for the production of a vaccine against human tuberculosis. This Bacillus Calmette-Guérin, or B.C.G., was produced over thirty years ago but was not generally accepted. Recently a five-year clinical trial by the Medical Research Council has shown that the vaccine gives good protection against tuberculosis.

The film shows that the liquid vaccine has a very short life of about fourteen days. A clever and imaginative sequence of planes in flight indicates that this vaccine must be flown to arrive in time. The Laboratory experiments on freeze-drying antibiotics at the Glaxo Laboratory are interestingly demonstrated. Prototype methods and apparatus and the methods of resuspending the vaccine are shown. Animal and later human tests were carried out to prove the effectiveness of the freeze-dry product.

The laboratory work proved successful so the process was developed on an industrial scale. Finally we see the vaccination of school children with the freeze-dried Vaccine.

As *The Griseofulvin Story*, reviewed above, this is a first-rate functional little film which does exactly what it sets out to do—no more and no less. Photography, colour and commentary are equally good. There is no attempt to make an art

film, but on the other hand there is no shoddiness, nor irrelevance in the production.

Glaxo Laboratories have produced three other films:

1. *Thought For Food*—A Nutrition Research Team Plans a Complete Food.
2. *Defence Against Poliomyelitis*—Manufacture and Testing of Poliomyelitis Vaccine.
3. *A Vitamin Emerges*—How Vitamin B_{12} was isolated, and how research is increasing knowledge of this vitamin.

L. GOULD-MARKS

Business Films: How to Make and Use them

By Peter Spooner (*Business Publications—Batsford, November, 1959, 360 pp., 45s.*).

Among the leading business and industrial film associations founded, as the Midland Industrial Film Association, in the last six years or so, it has already become an accepted tenet that the film is the most versatile tool in any branch of enterprise, large or small and that the cost need no longer be prohibitive either to making a film, or commissioning its production by a professional company. Spooner's excellent and comprehensive handbook reinforces and summarises all there is to know and to learn about commercial films, from—this is the change—the businessman's angle, not as so many studies of recent date, from the film maker's point of view.

The reviewer, associated for years with both sides involved, can safely recommend the book to business executives for close study and frequent references. The many excellent hints and practical references will amply repay the time spent in reading and re-reading the book. The reviewer is, in fact, in a dilemma whether to praise chiefly the clearly transmitted expertise of Mr Spooner, or to emphasise his excellent idea of including reference sections on materials and equipment for film and sound recording, professional and ancillary services, lending libraries, etc., and above all, advertising media related to film and screen.

If MIFA or similar organisations, interested in business films, had commissioned this work, they would have shown foresight and put themselves into the front line of film progress in commercial fields. As it is, this independent study is most welcome to all associated with industry, training and research, in all aspects, and should be in every reference library, for it gives a wide and wisely selective, eminently practical guide to a perplexity of offerings.

J. HORNE

COMING EVENTS

OCTOBER

1– 2 LONDON
Symposium on Enzymes in the Manufacture, Storage, and Distribution of Food
Society of Chemical Industry, 14 Belgrave Square, London, S.W.1

3– 6 VARENNA, ITALY
International Speleological Symposium
Salvatore dell'Oca, Via Mentana 22, Como, Italy

4– 7 BERLIN
International Rubber Conference
Deutsche Kautschuk-Gesellschaft, Mainzer Landstrasse 66, Frankfurt-am-Main, Germany

4–22 SEVRES, FRANCE
Meeting of the International Committee of Weights and Measures
Bureau International des Poids et Mesures, Pavillon de Breteuil, Sèvres (Seine-et-Oise), France

5– 7 LONDON
National Conference on Deafness
National Institute for the Deaf, 105 Gower Street, London, W.C.1

5– 9 BADEN-BADEN
6th International Convention on Nutrition and Vital Substances
61 Bemeroderstrasse, Hanover, Germany

6– 8 MIDDLESBROUGH, YORKS.
Annual Clinical Meeting of the British Medical Association
BMA House, Tavistock Square, London, W.C.1

11–13 LONDON
2nd International Symposium of Synthetic Rubber
Rubber and Plastics Age, Gaywood House, Great Peter Street, London, S.W.1

11–19 PARIS
11th General Conference of Weights and Measures
Bureau International des Poids et Mesures, Pavillon de Breteuil, Sèvres (Seine-et-Oise), France

16–22 WASHINGTON, D.C.
5th International Congress on High-Speed Photography
Society of Motion Pictures and Television Engineers, 55 West 42nd Street, Suite 1004, New York 36, N.Y.

17–21 WIESBADEN
Autumn Meeting of the Union of German Physical Societies
Physical Institute of the University of Frankfurt-am-Main, Robert-Mayer-St. 2, Frankfurt-am-Main, Germany

17–22 SEVILLE
International Symposium on Problems of Nitrogen in Agriculture
Istituto de Chemica Agraria, Università de Pisa, Via S. Michele degli Scalzi 2, Pisa, Italy

19–26 DÜSSELDORF
2nd International Congress and Exhibition for Measuring Techniques and Automation
Nordwestdeutsche Ausstellungs-Gesellschaft, Ehrenhof 4, Düsseldorf, Germany

24–27 VIENNA
Symposium on Chemical Effects of Nuclear Transformation
International Atomic Energy Agency, 11 Kaerntnerring, Vienna 1, Austria

26–30 CHICAGO
Congress of Neurological Surgeons, Meeting
101B, 20, S. Dudley Street, Memphis 3, Tennessee

NOVEMBER

7–10 GALVESTON, TEXAS
30th Annual International Meeting of the Society of Exploration Geophysicists
Mr Walter B. Lee, c/o Gulf Oil Corporation, Drawer 2100, Houston 1, Texas

7–13 TOKYO
International Symposium on Numerical Weather Prediction
American Meteorological Society, 3 Joy Street, Boston 8, Massachusetts

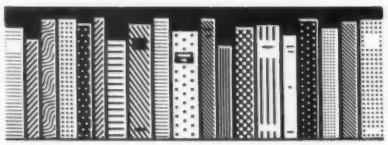
14–18 LONDON
London Medical Exhibition
British and Colonial Druggists Ltd, 194 Bishopsgate, London, E.C.2

DECEMBER

1–16 LONDON
3rd Session of the Commission for Climatology
World Meteorological Organisation, Campagne Rigot, 1 Avenue de la Paix, Geneva

7– 9 LONDON
Winter Conference of the Royal Photographic Society of Great Britain
Mr D. Brownbill, Technical Service Department, Ilford Ltd, Roden Street, Ilford, Essex, England

19–20 LONDON
Conference on Statistical Mechanics
Organising Secretary, The Physical Society, 1 Lowther Gardens, London, S.W.7



THE BOOKSHELF

The Correspondence of Isaac Newton
Vol. II, 1676–1687
Edited by H. W. Turnbull, F.R.S. (*Cambridge, published for the Royal Society at the University Press, 1960, xvi+522 pp., 6 plates, £7 7s.*)

The Royal Society: Its Origins and Founders
Edited by Sir Harold Hartley, F.R.S. (*London, The Royal Society, 1960, 275 pp., 29 plates, 35s.*)

A Brief History of the Royal Society
By E. N. da C. Andrade, F.R.S. (*London, The Royal Society, 1960, 28 pp., 14 plates, 10s. 6d.*)

The Beginning of the Royal Society
By Margery Purver and E. J. Bowen, F.R.S. (*Oxford, Clarendon Press, 1960, 16 pp., 2 plates, 2s.*)

For some time past it has been generally known that one of the more enduring monuments to the tercentenary celebrations of the Royal Society would take the form of the publication of a substantial instalment of the Newton Correspondence collected and edited on the Society's behalf by Prof. H. W. Turnbull, F.R.S. The first volume appeared towards the end of last year, the second (here reviewed) greeted the delegates from all parts of the world as they assembled at Burlington House on July 18. It was less generally known that a team of contributors was being partly driven, partly coaxed, by the indefatigable Editor of the Society's *Notes and Records*, Sir Harold Hartley, to investigate and report on the lines of the twelve signatories of the extant document which on November 28, 1660, gave corporate existence to what had before been a somewhat loosely articulated "club" for the prosecution of "mathematicall, experimentall learning". To these twelve biographies (John Wilkins, Jonathan Goddard, William Petty, Christopher Wren, Laurence Rooke, Robert Boyle, William Brouncker, Paul Neile, William Ball, Abraham Hill, Robert Moray, and Alexander Bruce) have been added those of Charles II (Founder and Patron), John Wallis (devoted and influential well-wisher), Robert Hooke (ever resourceful "Curator of Experiments"), William Croone (first "Register"), John Evelyn (by whose hint in the right quarter the Society gained its Royal title), Thomas Willis, Kenelm Digby, and Elias Ashmole (active participants from early days) and Henry Oldenburg, whose foreign correspondence and *Philosophical Transactions* rapidly established the Society in the highest esteem among European *savants*. The long preliminary examination of the Society's origins by Prof. D. McKie and Sir Harold Hartley's assessment of the abiding and cumulative influence of the Society in respect of the advancement of knowledge round off a work which in originality of design and comprehensiveness of execution is not unworthy to stand beside the Newton Correspondence as a memorial of an *annus mirabilis* in the Society's life.

The other two works, also published during the celebrations, are on a much more modest scale. Prof. Andrade's *A Brief History of the Royal Society* is somewhat misdescribed since, though it abounds in such historical allusions as we are accustomed to expect from this author, it is rather a neat and lively portrait of the Society embellished with ten beautifully reproduced portraits of Presidents and of Fellows of singular interest. There are also four illustrations of important documents, including the first number of the *Philosophical Transactions* which the unsuspecting reader might infer to have been always published by the Society. This was explicitly not the case until 1753.

The last of the four works—the only one not bearing the Society's imprint—somewhat resembles the impression created in a Sassenach by the pipes which precede the haggis at a Burns Supper. He is startled and he is interested in the possible implications but he has an uneasy feeling that the incursion has been made in an inappropriate setting. This attempt to revive, after two centuries, Sprat's claim that the meetings in Wadham College, Oxford, "laid the foundation of all that followed" appears to the reviewer to be an interesting academic exercise in support of which many witnesses are called, some of whose testimony will be unfamiliar to the majority of those who have studied the history of the Society. Unfortunately, no witnesses are called for the view (traditional since Birch, 1756) that the Oxford meetings were a continuation of those held in Gresham College from 1645. Worse still, the weight to be attached to Sprat's evidence is nowhere considered. It cannot, then, but be regretted that this polemical claim should have been published at a time when delegates from every quarter of the world were assembled to do honour to the Society without the time or the facilities for a judicial examination. It is

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therefore much to be hoped that before they accept the implicit claim that "the Royal Society began at Oxford" (whatever precise significance is to be attached to this sentence) they will read carefully Prof. McKie's much weightier examination of the question of "beginnings" which precedes the biographies already referred to. Not only here, but in the whole of this volume, though there may be room for differences of opinion in regard to details, the dominant aim is the re-examination of the evidence rather than the establishment of any sectarian claim. Since space does not permit of justice being done to all the contributors, it would be invidious to single any out for special notice. They have, in Sprat's words, "studi'd to make it not only an enterprise of one season" but "a steddy, a lasting, . . . work" which will be a source of entertainment and knowledge long after the occasion which gave it birth has passed into the shadows.

The second volume of *The Correspondence of Isaac Newton* contains 162 items, the great majority of which are, of course, letters written by, or to, Newton. But the value of the volume to the historian is greatly enhanced by the inclusion not only of some key manuscripts from Newton's hand (the neatness of which is well shown in several reproductions *facsimile*) but also a number of letters which passed between his correspondents, giving depth to the historical scene in which the events occurred. The period covered stretches from April 1676 to January 1688 NS—the year following the publication of the *Principia*. No fewer than sixty-six of the items included are, so far as the Editor has been able to discover, published for the first time; the provenance of nearly every item is clearly indicated.

W. P. D. WIGHTMAN

Russian Review of Biology

(*Institute of Biology and DSIR, Bi-monthly, 30s.*)

Most British biologists would like to know more than they do about what is going on in Russian research laboratories, and also to gain some impression of the climate of opinion among their scientific opposite numbers in the U.S.S.R.

The Institute of Biology and the Department of Scientific and Industrial Research have united in a spirited attempt to meet this need. A complete English translation of one of the Journals of the U.S.S.R. Academy of Sciences (*Uspekhi Sovremennoi Biologii—Advances in Contemporary Biology*) is being made, issue by issue, under the English title "Russian Review of Biology". The Review is to be published six times a year under the editorship of Prof. H. Munro Fox, F.R.S. The first number of the English edition has now appeared, and is the translation of No. 1 of the 1959 volume of the Russian journal.

This first translated issue consists of review articles on the philosophy of science, on polynucleotide phosphorylase, on applied enzymology, on xanthine oxidase, on erythrocyte sedimentation, and on immunological tolerance. The last item is a "guest article" by Milan Hašek of Prague, whose work is already well known in Britain. There is, in addition, a detailed account by K. H. S. Koshtoyants of his visits to various laboratories and scientific workers in Cambridge.

D. MICHIE

Science and Engineering in American Industry: Report on a 1956 Survey by National Science Foundation

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prehensive survey of funds and personnel for industrial research and development which has been prepared for it by the Bureau of Labor Statistics, U.S. Department of Labor. These surveys, which seem to be developing into annual events, are of significance not only because of the light they shed on the position of science in the U.S. economy, but also because they invite comparisons with similar studies by the DSIR on Scientific Expenditure and Manpower in the United Kingdom in 1955 and 1958. Not only does this process spotlight the fact that U.S. research expenditure is very much higher than that in the U.K., but we are bound to recognise that the anatomy of scientific outlay is charted in far greater detail in the United States than in Britain. In particular, the procedures for sampling U.S. industry's expenditure appear to be more comprehensive. Quantity need not be synonymous with quality and while one may discount the bulkiness of some U.S. Government publications, the fact that *this* publication covers 116 pages, as against 13 in the DSIR's Report on 1958 is not without a certain importance. We do not underestimate the work that the DSIR do in this field but we would make a plea for the authorities to do very much more, since a more effective scientific effort must needs have more statistical data on its deployment.

As to the facts, these need not surprise us. U.S. industrial research and development in 1956 stood at three-quarters of the 8·5 billion-dollar volume of research and development performed throughout the economy. Perhaps even more striking was that the three preceding years had witnessed a 75% increase in the dollar-volume of research and development expenditure. While private industry's own finance played its part, the principal force in that period was the growing expenditure of the Federal Government. As to the pattern of industry's expenditure, 4% was on basic research, 20% on applied research, and the balance on development activities. As in Britain, research and development expenditure by the American aircraft industry took pride of place; indeed, it accounted for 60% of state-sponsored research and development. The electrical industry led the way so far as research expenditure by small firms was concerned. Significantly, scientific outlay is tending to rise faster than sales by industry, as is the case in Britain. Whether this results from the sluggishness of our two respective economies, or whether the ever-growing need for research is the *sine qua non* of economic expansion, is a matter for the fullest examination.

Evolution above the Species Level

By Bernhard Rensch (*Methuen & Co., 1959, 419 pp., 63s. net*)

This is an English translation of the second edition of Rensch's well-known book published in German as "Probleme der Abstemmungslehre" (second edition 1954, first edition 1947). The greater part of the book was written during the last years of the war and the coverage of literature since then is naturally rather scanty. The theory of evolution, however,

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THE AEROPLANE

An Historical Survey

by C. H. GIBBS-SMITH

Man's conquest of the air has probably had a greater effect upon his story than any other discovery. This new book traces the origin and birth of the practical aeroplane from Sir George Cayley to the Wright Brothers and its subsequent development in Europe and America during the early part of the century. The first survey of its kind to have appeared for many years, it includes a table of early flights and flight attempts, a chronology of aviation, a bibliography, and more than 180 illustrations. **35s.** (*post* 2*s.*)

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is a subject which advances with something of the majestic ponderousness of evolution itself. This is particularly the case when we are considering the major problems of evolution on the grand scale, which is Rensch's theme.

To the English-speaking biologist, Rensch's work will be of particular value in bringing to his attention much important German work which is likely nowadays to be overlooked in the scramble to keep up to date with the most recent advances. For instance, amongst the most frequently cited authors are Abel, Beurlen, Hennig, Plate, Schindewolf, Sewertzoff, and Zeihen. The British reader is likely to miss the names of such palaeontologists as Elles, Swinnerton, Rowe, Spath, Bulman, and others whose contributions were perhaps of little less importance than those of their German colleagues. It is, however, rare enough to find any attempt made to bring the palaeontological findings into relation with those of modern genetics, and this Rensch does with sympathy and critical insight.

The most impressive feature of Rensch's book, and the one which entitles it to be ranked amongst the major works in biology of his time, is the breadth and inclusiveness of the problems which he tackles. After two introductory chapters, on the causative factors of intraspecific evolution and on types of race and species formation occurring in nature, the main body of the book is concerned with trans-specific evolution. Rensch's interpretation of this is, in general terms, that it does not call for the invocation of any special processes other than those which we can see to operate at the intraspecific level. He emphasises the existence of many systematic regularities and "rules" which apply rather generally in the trans-specific realm but regards these as high-level resultants of the normal small-scale processes rather than new self-sufficient principles.

In his last chapter, Rensch shows both the boldness and depth of his mind by tackling a problem of which most biologists fight shy—the "evolution of phenomena of consciousness". Rensch is one of the few biologists who combine a profound knowledge of the facts of evolution with an intimate working knowledge of experiments on animal learning and capacity for conceptual thought. He has himself (mostly since this book was written) done important work on such subjects as the training of elephants and the (conceivably aesthetic?) painting of chimpanzees. He was also one of the first to construct machines which show the elements of purposive behaviour and learning, in the manner which has since been developed by Grey Walter and others. His views on the relations between evolutionary processes and the phenomena of subjective self-awareness are therefore of the greatest interest. They are both bold and original. He finds himself driven to attribute a capacity for sensation to the lowest organised creatures which can be shown to be capable of learning, that is, coelenterates and possibly even protozoa. He seems, in fact, to agree in general with the outlook of A. N. Whitehead (to whom he does not refer) that something which belongs within the same realm of being as consciousness has to be attributed to all existing things, including the inanimate.

C. H. WADDINGTON

An Introduction to Animal Husbandry in the Tropics

By G. Williamson and W. J. A. Payne (*Longmans, London, 1959, xix+435 pp., 48 plates, 48s.*)

A large proportion of the domestic livestock of the world is found in the tropics. Low levels of productivity and low standards of husbandry prevail and the need to improve these has gained much attention in the post-war period. It is remarkable that this book is the first attempt at an integrated text on tropical animal husbandry. In covering conditions ranging from semi-arid steppes to super-humid rain forests, and from large-scale ranching to peasant subsistence farming, the authors have a difficult task but they preserve a good balance and integrate the general and the more specific discussions without confusion.

Improvement of livestock productivity in the tropics, the human, social, and economic problems are as important as those associated with climate, nutrition, diseases, and parasites. The authors have given sympathetic and realistic consideration to these.

The material is presented in three parts dealing firstly with climate, health, nutrition, and breeding, secondly with each domestic species, and thirdly with the handling of animal products. It is difficult to know whether the book should be written as a tropical supplement to standard texts or as a complete text in itself. The authors have leaned towards the latter but, in presenting standard material on such subjects as nutrition and breeding, have mostly imparted a fresh, topical point of view. Twenty pages on the elements of breeding and genetics are not so leavened and might have been replaced by reference to standard texts. In a book designed partly for readers unacquainted with technical literature, it is unfortunately that some references are carelessly cited. For these readers, selected

The Coast of England and Wales in Pictures

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The second of four volumes, planned as a companion to the text by A. R. CLAPHAM, T. G. TUTIN and E. F. WARBURG which is now the standard work. This volume covers the families *Rosaceae —Polemoniaceae* and contains 459 drawings by SYBIL J. ROLES. 25*s. net*

Evolution after Darwin

EDITED BY

SOL TAX

The proceedings of the Chicago Centennial Celebration. Volume I, *The Evolution of Life*, is concerned with evolution in biology; Volume II, *The Evolution of Man* deals with the concept of evolution in anthropology, sociology and psychology. The papers are all clear, readable and authoritative, but demand a minimum of background knowledge. Volume III, *Issues in Evolution*, is expected in 1961. UNIVERSITY OF CHICAGO PRESS.

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bibliographies of supplementary reading would be helpful.

This interesting synthesis of the knowledge and experience of the authors and their colleagues should be valuable to many students, administrators, advisers, and owners concerned with tropical animal production. H. G. TURNER

Plant Marvels in Miniature

By C. Postma (*London, George G. Harrap & Co. Ltd., 1960, 173 pp., 77 plates, 45s.*)

A most remarkable book of botanical photographs. The author, who is first a scientist and secondly an outstanding photographer, has presented a series of the finest photographs of parts of plants, each at a higher magnification, together with a short but accurate description of the portion of the plant and its function.

It is a little difficult to decide for whom this delightful volume was produced as it is not a "botanical book" in the usual sense, nor is it simply a book of unconnected photographs. We are told by the author that it is for laymen and intended to give a glimpse of the hidden beauties and complexities of the plant world. In this it has succeeded admirably. No one can look through this book, even in a most cursory manner, without being struck by the very great beauty and perfection of the illustrations. Many of them are most dramatic in presentation, due in large part to the very frequent use of the dark ground method. For example, Plate 10, Grains of Wheat (× 11) is a common enough photograph of a common enough object. Dr Postma's photograph, however, is in a different category. It shows this common object as a thing of beauty in a photograph which is a real masterpiece. The whole book is on this same high level.

A particularly interesting part of the book to any photographer is that devoted to the photographic techniques employed.

One must not be carried away too much by the perfection of the photographs however. The description of each is, in itself, most interesting. Although a botanist would doubtless be familiar with all the points involved, the layman will find much to interest and fascinate him.

R. McV. WESTON

Handbook of Toxicology, Vol. III: Insecticides

By W. O. Negherbon (*Philadelphia and London, W. B. Saunders (for National Academy of Sciences), xxv+854 pp., 98s.*)

After seeing two senior scientists at the Quartermaster Research Center investigating the sex life of various cockroaches, your reviewer was more than ever impressed by the bizarre scientific activities supported by the United States Forces. It is scarcely surprising, then, to find a five-volume compilation on toxicology sponsored by the U.S. Air Force. One presumes that the funds came from the enormous sums voted for defence; in other respects, it appears, the work was prepared under the direction of a committee of the National Academy of Sciences and the National Research Council.

The volume under review deals with insecticides; other volumes deal with (*i*) substances toxic to laboratory animals; (*ii*) antibiotics; (*iii*) tranquillisers; and (*iv*) fungicides. "Handbook" seems a diminutive description, since this single volume, with nearly 900 pages (8½ in. × 11 in.), weighs over 4 lb. It contains 188 sections, 164 of them dealing with particular substances used as insecticides and 24 on general topics, such as "insecticidal fumigants" or "resistance". Since the work is obviously for reference rather than sustained reading, they are arranged alphabetically. Some 3400 references are extracted (up to the end of 1957) and the aim has been to quote as much compressed information as possible. Many quantitative data are given in tables; and while this seems logical, one should remember that results of tests are not always entirely easy to interpret, without reading the original paper. Several aspects of the subjects are discussed in brief textual summaries, which seem sound and helpful. There are cross indices to insects and to chemicals mentioned at the end. Mr Negherbon is to be congratulated. He himself passes a bouquet to the U.S. Air Force "which, in the immensity of its activities, has recognised the primacy of knowledge and sought to promote it in so many fields". What more can one add?

J. R. BUSVINE

LETTERS TO THE EDITOR

Science on Television

Sir:

Prof. Tolansky, in his article in your August number on Scientific and Educational Television in the U.S.A., adds his own enthusiastic tribute to the already much-publicised Hagerstown Experiment. It is a pity he could not do so without misinforming your readers on the way educational television operates in this country.

"A planning committee of the teachers themselves has organised the programmes", he writes, "and how much better this is than our system of lessons imposed by BBC or ITV producers." To talk of imposition is anyhow nonsense when each school is completely free to use or not to use any programme offered; but does Prof. Tolansky really imagine that the producer, or the broadcasting organisation, in this country is the sole judge of what shall be broadcast, and how? The BBC for its part has for decades been guided, first in sound broadcasting and now in television also, by committees of teachers and other educationists who determine the main lines of each programme series and vet the detailed proposals: their powers are mandatory. A continual flow of teachers' reports, and series of consultative meetings both formal and informal, perform the same function here as in the U.S.A.: in the BBC they are supplemented by the work of fifteen field officers entirely devoted to liaison with the world of education. This organisation, which is in the care of the School Broadcasting Council, has long been regarded here as a model of its kind.

The final shaping of any programme must, of course, be the responsibility of one man: committees cannot do the job, here or anywhere else. In the BBC he is an educationist with many years of classroom experience behind him: does Prof. Tolansky imagine that all this is jettisoned when he comes to produce, not "lessons" (the word, if appropriate to television at all, is certainly more relevant in Hagerstown than in the U.K.), but imaginative supplements to the classroom teacher's own work?

KENNETH FAWDRY

Head of School Broadcasting,
BBC Television Centre,
Wood Lane, London W12

Australian Solar Furnace

Sir:

May I call your attention to the fact that in the April edition of DISCOVERY appears the statement: "A special solar furnace now being constructed by Australian scientists in the grounds of Sydney University. . . ."

All the facts about this solar furnace are correct except for the rather important one, that it is being constructed in the grounds of the University of New South Wales. GEORGE CAIGER

Public Relations Officer,
The University, New South Wales.

NEW SCIENTIFIC INSTRUMENTS

ARTHUR GARRATT

The rapid evaluation of gas temperatures in industrial furnaces is complicated by fumes and slag and there is usually an upper limit above which suction pyrometers will not function. These difficulties are obviated by an ingenious instrument, the Venturi Pneumatic Pyrometer (1), in which intelligent exploitation of the gas laws allows the actual measurement to be made at a much lower temperature than the gas. A stream of furnace gas is drawn into a water-cooled probe 11 ft. long and 2¼ in. diameter through a ½ in. bore venturi-type orifice and then through a second—cold—venturi. The temperature is measured just after the cold venturi where its value is a simple function of the original temperature and the ratio of the pressure drops through the orifices.

A Needle Pyrometer (2) is available which will determine temperatures below the surface of materials like rubber and plastic. Completely portable, the pyrometer is made in two versions, one reading from 0° to 200°C, the other from 50° to 400°C. Other ranges can be supplied on request. There seem to be numerous applications for this instrument including the measurement of temperatures of food during cooking.

A Transistorised Crystal Chronometer (3) has been built which is accurate to ± 2 parts/million over a 24-hour period giving a daily drift of less than 1 part in a million, or ½ sec./week. So far it has been used largely in television studios for master and slave clock operation and to operate count-down indicators, but numerous other applications, such as synchronisation of chronometers from time signals not in the same location, are envisaged. Another Crystal-Controlled Chronometer (4) which is fully transistorised and contained in a case 10¼ in. square and 8¼ in. deep has been announced. It operates on a 12-V DC supply and consumes 1 amp. so that a trickle-charged accumulator can drive it without any danger of stoppage due to mains failure. It has been developed for marine use but is available as a compact portable frequency standard of $0{\cdot}5 \times 10^6$ accuracy.

A 12-Channel Direct-Writing Recording Camera (5) is now available. It can record frequencies greater than 1 kc./sec. with a choice of eight paper speeds, the fastest being 150 in./sec. There are three additional channels for time or event marking.

A 3-D Microscope (6) has been built which projects an image of a solid object in a "cube of space". In the original model the focusing mechanism is vibrated at above the physiological flicker frequency in synchrony with a vibrating screen on which the image is projected. It is proposed to replace the vibrating system by two rotating optical elements on a single shaft in later designs. This microscope permits the study of objects in depth. A present limitation is lack of contrast due to ambient light in the image cube space. Possible applications are the examination of emulsion blocks in cosmic-ray research and living cells.

Among the new medical instruments is the Meditherm Electric Thermometer (7). The temperature-sensitive elements are thermisters only 1 mm.³ in volume. They have a large temperature/resistance coefficient and high resistance so that lead-resistance effects are eliminated and differential temperatures, using two thermistors, can be measured to ±0·05°C.

A new Oxygen Analyser (8) which measures oxygen concentrations in gases or liquids including blood and other biological fluids, is available. It works on a new principle, that of "potential interruption", using a platinum micro-electrode as a capacitor. This is charged, the charge removed, and the fall in charge in a fixed time interval is measured, the whole cycle being repetitive. It features a sensitivity switch with four positions, the first covering the range 0 to 2% oxygen, the last 0 to 100% oxygen. Its accuracy is about ±2%. Anaesthetic vapours do not affect the electrode.

A Field Emission Microscope (9), or Müller projector, is now being used industrially to study adsorption on the surface of a catalyst. A high voltage is applied between the metallic catalyst crystal which forms the cathode and a fluorescent screen on which the emission is observed. Groups of four to six positive ions due to atom adsorption show as bright spots on the image which can be magnified a million times.

Several laboratories are working on fuel cells at the present time. A new Fuel Cell (10), claimed to generate from three to five times more power per unit volume than other cells under development, has just been announced. The high output is due to new fuel cell electrodes which are cheap and easily manufactured. When run on hydrogen and oxygen at a pressure of 3 lb./in.², current densities of 70 amp./ft.² are obtainable. When the cell has heated to 60°C, the output is doubled. The laboratory believe that units with a power/weight ratio of 50 watts/lb. are realisable.

The electrolytic tank is a very valuable research tool, though it is difficult to use and usually rather messy. A two-dimensional dry version of it, called a Field Plotter (11) is now on sale. Instead of a liquid, the resistance analogue is built up on special resistance paper with silver electrodes painted on it. The idea is not new, it was first described by Kirchoff in 1845, but its exploitation awaited a satisfactory resistance material. An accuracy of 5% can easily be achieved and improved with extra effort in plotting the analogue.

MANUFACTURERS

1. *Venturi Pneumatic Pyrometer.* British Coal Utilisation Research Association, Leatherhead, Surrey.
2. *Needle Pyrometer.* Cambridge Instrument Co. Ltd, 13 Grosvenor Place, London, S.W.1.
3. *Transistorised Crystal Chronometer.* Automatic Telephone & Electric Co. Ltd, Strowger House, Arundel Street, London, W.C.2.
4. *Crystal-Controlled Chronometer.* Sperry Gyroscope Co. Ltd, Gt West Road, Brentford, Middlesex.
5. *12-Channel Direct-Writing Recording Camera.* Savage & Parsons Ltd, Watford.
6. *3-D Microscope.* Cambridge University Psychological Laboratory, Cambridge.
7. *Electric Thermometer.* Ing. Burea Weisheit & Co., Essenstadtwald, Germany. British Concessionaires: Research Interests Ltd, 79 Davies Street, London, W.1.
8. *Oxygen Analyser.* British Oxygen Research & Development Ltd, Deer Park Rd., London, S.W.19.
9. *Field Emission Microscope.* Shell International Petroleum Co. Ltd, 1 Kingsway, London, W.C.2.
10. *Fuel Cell.* Shell International Petroleum Co. Ltd, 1 Kingsway, London, W.C.2.
11. *Field Plotter.* Servomex Controls Ltd, Crowborough, Sussex.

(continued from page 419)

Population Growth

In arriving at its forecast of 6000 million people by the year 2000, the UN estimated a 70% increase in the developed countries, a 150% increase in Africa, a 180% increase in Asia, and a 250% increase in Latin America.

D. V. Glass, Professor of Sociology at the University of London, indicated the increases may be even greater. Mortality may fall more rapidly than the UN has assumed, he stated, and the spread of birth control and the small-family pattern is still an open question. The drive to reduce mortality is likely to become more rather than less intense. In the less-developed countries, the knowledge of how to improve health is much greater and the costs far smaller than in any earlier period. Even if birth control were accepted fairly widely in the near future, populations would continue to grow substantially for some time. The speed and extent of the spread of birth-control measures is still a large unknown, however. In the first place, it is by no means certain that many countries would ask for advice and assistance if it were available. Although they would adopt a policy of reducing mortality without hesitation, a reduction of fertility would be an admission that their rate of growth was not rapid enough to meet the population increase. Secondly, the provision of advice and assistance through the UN scarcely seems practicable at present. It is doubtful if proposals for such assistance would be supported by Communist member states, partly from theoretical considerations, although they are increasingly accepting birth control for their own populations; the Catholic member countries are likely to be more forceful and persistent in their opposition. Although the policy of the Catholic Church has not seriously impeded the spread of birth control in Western societies, even among Catholics (save in Eire and the Netherlands), the Church's views have certainly made it more difficult to assist the adoption of birth control in underdeveloped societies, whatever the religious beliefs of the population concerned. Finally, even if birth control was adopted as a national policy by the various countries, it would be unwise to assume any sharp changes in the levels of fertility. Studies undertaken so far offer no sure guide to the techniques for promoting birth control and smaller family size in countries with low literacy and numerous rural communities. In sum, a realistic programme for international action should allow for a yearly increase in the world population of 1·6% or more. It should not be assumed that the decrease in fertility will be very rapid. We must be prepared for a very massive underpinning of planned economic and social change because the time-scale of change has shortened drastically from that in 19th-century Europe when the annual population growth was only about 0·75%, when the levels of living to which societies ascribed were much lower, when newly settled lands could accommodate considerable migration, and when the migration itself increased the food supply.

Economic Conditions for Greater Output

Prof. W. A. Lewis, Principal of the University College of the West Indies, discussed the economic conditions necessary for increased food production in the third presentation at the symposium. The non-farm sector of the economy must be expanded if the farm output is to grow faster than the population, he pointed out; otherwise there will be no market for the increased produce and further expansion of farming will be discouraged. It is also necessary to make certain that the fruits of the farmer's investment accrue to him rather than to landlords or creditors, a problem that is serious in some of the poorer countries. Although price stability is often claimed to be necessary, Prof. Lewis contended that the freedom of prices to rise adequately in response to the increasing demand is more important. In addition, the rapid development of small farms will be possible only if the farmers have access to new knowledge, capital, and services which are generally economical only on a large scale. This will require considerable initiative by governments in such activities as research, agricultural extension, financing, the development of water supplies, disease control services, and plant-breeding stations.

Land Use

Only 30% of the earth's land surface is cultivable—about four acres per person. This includes, however, the vast equatorial forests of the Amazon, Congo, and Indonesia as well as the huge stretches of tropical savanna and grassland where many problems of land management remain to be solved. The land actually in use today amounts to only 1·1 or 1·2 acres per head. As Dr L. Dudley Stamp, Professor Emeritus of the University of London, noted during the symposium, this figure—a world average—is misleading since there are great differences between the "have" and "have-not" nations. Canada is at one extreme with 21·5 cultivable acres per person and only 3·5 of them in use. Japan is at the other extreme with about 0·2 cultivable acres per person and 0·17 in use. Britain, like Japan, has

FAO expert and assistant (*at right*) show a modern scythe to three Ethiopian farmers. (*United Nations*)

most of its cultivable land utilised—0·55 acres out of 0·6 per head. Despite its staggeringly small acreage, Japan comes close to feeding her own population by relying on high-calory rice and protein-rich beans, double and treble cropping, and fishing. Intensive cultivation produces twenty times as much food per acre as that required in other countries for a milk and meat-based diet.

Industrial and Technological Needs

Sir Alexander Fleck, a past president of the BAAS, discussed three types of technical problems: the problem of providing crops with adequate water and nutrients, the problem of equipment, and the problem of waste. The nutrients needed by crops are, essentially, fixed nitrogen, phosphorus, and potassium. There is an adequate supply of the latter two for years to come; the amount of nitrogen in the atmosphere is virtually unlimited. Though the production of fertiliser nitrogen has advanced by leaps and bounds to 10 million tons a year, a greater supply could profitably be utilised. Japan, using more nitrogenous fertiliser than any other country in the world, gets 35 cwt. of yield per acre from her paddy fields; India gets only a quarter as much. Japan gets its high yield by using 100 lb. of fertiliser nitrogen per acre and supplementing this with a copious amount of natural manure; India, on the other hand, uses only 1 lb. of nitrogenous fertiliser per acre. In Japan, the wheat grown is 17 cwt. per acre; in India it is only 5·5 cwt. per acre. An extra 7 million tons per year of nitrogen in the Far East would bring about a vast improvement in food supplies and general social conditions. The quantity used in that region at present is less than 2 million tons a year. For the entire world, 30 to 60 million tons may be needed by the end of the century. The Bhakra-Nangal hydroelectric plant in India will divert part of its 900,000 kW. capacity to the production of 70,000 tons of fertiliser a year. A similar output is expected from another massive scheme based on the opencast mining of lignite in Southern India. The Indian practice of using cow dung as fuel, however, results in the staggering loss of 1 million tons of nitrogen a year; the development of alternative energy sources should put an end to this waste.

After fertilisers comes the need for more water. Irrigation has been practised for at least 4500 years and some of the equipment used today has changed little during that time. Countless pole-pumps in India and foot-pumps in China are worked by human muscle power and irrigate only about 4 acres each. The numerous water-wheels operated by animals each serve up to a dozen acres. There is a great need for electric pumps that will supply several hundred acres of land from a deep tube well. The use of river water for irrigation must also be greatly expanded; the Kariba and Bhakra Dams are only beginnings.

Next in importance is the need for machinery, particularly for jobs that are virtually impossible to do in any other way. The West must not thrust undiluted techniques of mechanisation on primitive smallholdings but, rather, help evolve new and simple tools appropriate to each situation.

There is also a need for a concerted attack on waste. Much food is lost because it can neither be promptly transported to where it is needed nor preserved without spoilage until it is ready to be consumed. The whole of a plant is seldom eaten although the part rejected may contain much nourishment in an inacessible or unpalatable form. Only a small fraction of the standing crop of the sea is made use of. All of these forms of waste can be avoided by technical means: speedier transport, deep-freezing plants, dehydrating plants, canning factories, tinplate mills, and so on. Waste can also be reduced by a more concerted attack on plant and animal diseases, insects, weeds, and vermin.

Science and Practice

The major obstacle to the fairly speedy improvement of nutrition in most of the hungry countries—even with the present rate of population growth—is not a shortage of basic scientific knowledge or a shortage of sound practical methods for applying this knowledge to agriculture or dietetics. It is, rather, the extreme slowness of implementation, a slowness caused by political, sociological, and psychological obstacles. In at least some of these countries, said Dr H. D. Kay, Professor Emeritus of the University of Reading, the members of the Government are not yet convinced that they have duties towards their people other than the preservation of law and order. Political instability may be a major cause of their backward condition. Effective methods must be found to instil into reluctant governments the awareness that they must act now to avoid famine later. They must be persuaded to devise a progressive agricultural policy and interlock it with a nutritional policy. Incentives must be found in each country to stimulate peasants and farmers to improve their output of food of the right quality. Self-imposed handicaps and taboos of ancient standing must be overcome. Techniques must be found for effectively dealing with these and other political, sociological, and psychological road-blocks.

REPORT FROM INTERNATIONAL ASTRONAUTICAL FEDERATION MEETING IN STOCKHOLM

Once again the occasion of the annual congress of the International Astronautical Federation has been marked by special space activities of the great powers. At the Eleventh Congress, held in Stockholm August 14–20, the American delegation admitted they had tried to lay on a good show. Just before the Congress they had three successes—the first recovery of a man-made object from a satellite orbit (*Discover XIII*), the launching of the passive communications satellite (*Echo*), and an ascent of the X–15 rocket plane to 131,000 ft. During the Congress, Gen. Flickinger was able to announce Capt. Joseph Kittinger's parachute drop from a record height of 102,000 ft., and *Discover XIV* was launched into orbit and later caught by plane after controlled re-entry into the atmosphere.

These activities were eclipsed by the Russians' recovery from orbit of their 4½-ton *arknik*. Prof. Leonid Sedov, leader of their delegation and last year's President of the IAF, hinted at this achievement at the start of the Congress when he announced that he had a lot of secrets in his little bag and some of them would be revealed during the Congress.

Five Russian papers were given in the technical sessions; they discussed the results obtained with the *Sputniks* and *Luniks*. Prof. A. A. Mikhailov described the techniques used to build up a complete atlas of the Moon with the aid of nine separate photographs taken from *Lunik III*, four with a short-focus camera and five with a long-focus one.

BRITISH CONTRIBUTION

Only three British papers were presented. Two were from the RAF Institute of Aviation Medicine and dealt with human frequency response to vibration, and the control of microclimate temperatures

in very hot environments. The third was a proposal for a repeater-type satellite capable of being launched by a two-stage vehicle made by combining the *Blue Streak* and *Black Knight* rockets. This was by Dr W. F. Hilton and S. R. Dauncey of the Astronautics Division, Advanced Projects Group, Hawker Siddeley Aviation Ltd. It has been usual to consider employing a circular orbit but the new proposal envisages the use of elliptical orbits with apogee heights of 8000–25,000 miles and perigees of a few hundred miles. The authors pointed out that these orbits could be chosen in such a way that the satellite communication link would be in service at times when the transocean cables were experiencing their peak traffic.

U.S. PROGRAMME

As usual, American contributions dominated the lecture sessions. The greatest attraction was undoubtedly the opening paper by Dr Wernher von Braun, Director of NASA's George C. Marshall Space Flight Center at Huntsville, Alabama. In it he outlined the United States Space Carrier Vehicle Programme for about the next ten years. The "third-generation" carriers *Scout*, *Thor Agena B*, *Atlas Agena B*, and *Atlas Centaur* will be coming into service in the next few years. The *Centaur* second stage is powered by two liquid-oxygen, liquid-hydrogen engines which can be switched on and off in space.

The "fourth-generation" carriers are based on the Saturn vehicle system; in its first configuration this is to be 185 ft. high, in a later version, 230 ft. The massive bottom stage has a cluster of eight engines with a total thrust of over 1,500,000 lb. Several static tests have already been run on this and no difficulty has been experienced in operating all eight engines at once.

Several papers were concerned with electrical methods of propulsion, in which a jet of ions and electrons is produced to provide the necessary thrust. These engines only work in vacuum and provide low thrusts, but are capable of prolonged operation. Some have already been run in the laboratory for 50 hours and will be tested in space next year. These engines will need considerable supplies of electrical power and two types of space power plant are being built for this purpose, each containing a nuclear reactor as heat source. The simpler SNAP 10 surrounds the reactor with thermoelectric units and contains no moving parts. Where several kilowatts are needed, SNAP 8 or SNAP 2 will be used; in these, the reactor heat is transmitted to a mercury boiler coupled to a turboalternator.

The Third Colloquium on the Law of Outer Space was also held in conjunction with the Congress. A large number of communications were read at this colloquium, but much the same things were said as in previous years. Some attempt was made to raise the question of the flights of the U.2 spy plane, but this was ruled out of order, the trial of the pilot in Moscow being then in progress.

THE ACADEMY OF ASTRONAUTICS

At the plenary sessions of the IAF Council, the statutes of the Academy of Astronautics were approved. This is to be an international body organised along the lines of the national Academies of Science, with divisions in the National Sciences, Engineering, and Social Sciences. Forty-five Academicians have been chosen and will themselves elect future additions to their ranks. Russian scientists have refused to participate as they think there are already sufficient international bodies concerned with space research and exploration. It is possible that within a few years this Academy will be in competition or conflict with the parent Federation. They are now separate bodies and the new Academy is the richer of the two, having received a grant of $75,000 from the Guggenheim Foundation.

NEW YORK NEXT YEAR

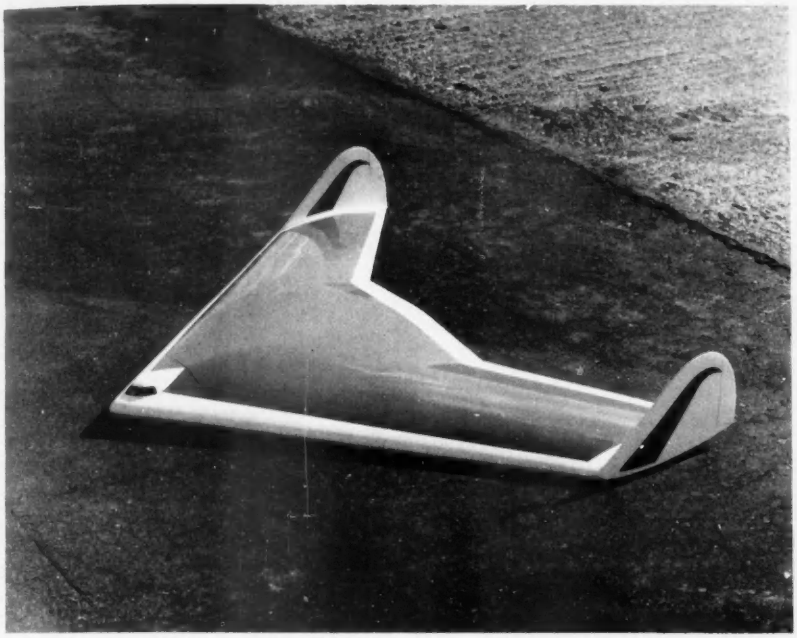
Prof. Sedov was re-elected President of the IAF for a second year. Next year's congress is to held in New York and will be organised by the American Rocket Society. If possible, it will be held in the United Nations Headquarters; the provisional date is October, 1961. Several thousand Americans are expected to be present (about 900 persons in all registered at Stockholm), but the ARS hopes that the cost of attending next year will not be so great that few Europeans can be present. It is possible that delegates may be able to visit the launching base at Cape Canaveral. The Americans are hoping to be able to produce at the meeting the first man to return from space, but it seems quite likely that he will have a counterpart in the Russian delegation.

Britain may be able to contribute more at New York than at Stockholm, but that will depend to some extent on whether the Government decides to go ahead with a space programme. There is certainly no lack of interest in the subject; three symposia are to be held in Britain shortly: "Navigation and the Early Exploration of the Moon" (British Interplanetary Society, and Institute of Navigation, November 18, at the Royal Geographical Society's lecture hall, Kensington Gore); "Rocket Propulsion" (BIS, Royal Aeronautical Society, and College of Aeronautics, January 6-7, 1961, at the College, Bletchley, Bucks.), and "European Symposium on Space Technology" (BIS, June 26–28, 1961, at the Federation of British Industries, 21 Tothill St., S.W.1).

REPORT FROM FARNBOROUGH AIR SHOW

Out over the Royal Aircraft Establishment's aerodrome at Farnborough, Hampshire, sixteen Hunters zoomed by in tight formation and the little vertical-take-off SC-1 hovered overhead to provide the more spectacular demonstrations of the Farnborough Air Show of 1960. There was also a parade of big commercial transports and awe-inspiring flights of the heavy V-bombers. To those who visit the Show yearly but are not connected with aviation it might have been difficult to recognise the great change taking place in the British aircraft industry's structure, but there were signs of it. It was most noticeable in the Exhibition Hall, where one had only to walk a short way round the stands to note that those twenty-six companies that formerly constituted the British aircraft manufacturing industry had been welded into sizeable units. As a result of the dictates of the former Minister of Aviation, there are now three main airframe manufacturing companies—the British Aircraft Corporation, the Hawker Siddeley Group, and the Westland Group. In contrast to this, the component and accessory manufacturers that have moved in on the aviation business since the war were apparently growing bigger than the industry which had initially provided their reason for existence. Now, there are some 400 companies "connected" with aviation which, in Britain, has become a diminishing industry.

There was certainly no dearth of ideas or lack of imagination on the part of the companies that exhibited at the Show, but the bad baron of the piece this year seemed to be the Government, for it was clear that the Government—which was responsible for the airframe companies' merging—had not come up with the orders or support for projects which had been promised. For this reason, many companies had become uncertain of their future and the projects they talked about



Scale-model of intercontinental HP 117

and displayed in model form were clearly going to get no further than the drawing-boards.

Of the new ideas put forward at Farnborough this year, Handley Page's were among the most interesting. This company has been talking of extended range operations by the employment of laminar flow surfaces for some years, and it has also been active in the field of boundary layer control. On the Handley Page stand in the Exhibition Hall were models of a machine that might be built for trans-Atlantic service. The HP 117 offered the promise of London to New York for £11. The all-wing subsonic aeroplane would make such a fare possible by carrying up to 300 passengers. Four engines would be housed in a central pack under the fuselage; there would be no windows. Yet another Handley Page idea was the HP 115, a developmental aircraft for a supersonic airliner for which the Government will have to put up most of the money.

Short Brothers & Harland's vertical-take-off SC-1 has tremendous potential for either military or commercial applications. It can lift straight into the air and then fly forward under the power of a propulsive turbojet engine. The Government has so far done nothing about furthering its development although twenty proposals have been put forward by the company. Another development that calls for comment is the Saunders-Roe S-R N2. This, the second version of the National Research and Development Corporation-sponsored "Hovercraft", has a more promising future and is now being built. It will weigh 25 tons, carry sixty-eight passengers, and travel at 70 knots under the power from four gas turbine engines.

There was evident development in other fields and much thought had clearly gone into designs. Smith's Para-Visual Director System for blind landings was clearly a system of the future, as was Elliott's automatic flight control system. There was no lack of thought or ideas at Farnborough this year, but with the suggestion that this was the last all-British year there is the feeling that the industry is being let down and needs a shot in the arm in the form of orders.

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